WILLAPA BAY

VOLUME I

THE COMMERCIAL FISHERY OF WILLAPA BAY

PART I The Fish, Clam and Crab Fishery

PART II The Oyster Industry of Willapa Bay

By J. Arnold Shotwell
Planning Division, Department of Public Works
Pacific County
1977

THIS REPORT WAS FINANCED BY A GRANT FROM THE WASHINGTON STATE DEPARTMENT OF ECOLOGY WITH FUNDS FROM THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, AND APPROPRIATED FOR SECTION 306 OF THE COASTAL ZONE MANAGEMENT ACT OF 1972.

REVISED

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FISH, CLAM & CRAB FISHERY
OF
WILLAPA BAY

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ACKNOWLEDGEMENTS

The following report depends heavily on past records concerning the fishery of Willapa Bay. Records concerning catch, licenses, hatchery and related data were supplied by the Washington Department of Fisheries in the form of published Annual Reports, Annual Bulletins, Statistical Reports and reports prepared for other agencies. Unpublished data was supplied by the statistics division of the Washington Department of Fisheries. Tabular material was in some cases, directly reproduced from those reports or as composites from material in these reports. We are indebted to Manny LeMier, Dale Ward and Gene Nye of the Department of Fisheries for supplying these records. Data concerning the international chum fishery was acquired from BCM Circular 315. Richard Stone and Herb Tegleberg of the Washington Department of Fisheries Coastal Fisheries Laboratory have read an earlier draft of this report and supplied comment and additional data which are incorporated here. They are however, not responsible for the final incorporation of this material. Data and original fish location permit applications were supplied by the Pacific County Auditor. Session laws of all the Legislative sessions were searched for relevant acts.

All of the graphic illustration is original with this report (except Figures 22, 23, 24 and 28) and constructed from the data and reports referred to above. Errors may creep into such a composite effort as this. We will appreciate having them brought to our attention.

The preparation of this report was financially aided through a grant from the Washington State Department of Ecology with funds obtained from the United State Department of Commerce and appropriated for Sections 305 and 306 of the Coastal Zone Management Act of 1972 (G-75-025D, G-76-025B, and G-77-025B).

Prepared by J. A. Shotwell, Planning Division

Department of Public Works, Pacific County

SALMON FISHERY

Fish are landed at Willapa Bay docks from both the bay and the adjacent Pacific Ocean. The bay fish include salmon, sturgeon, sharks, smelt, shad, and anchovy. Ocean fish include a small amount of troll salmon, albacore tuna, and various bottom fish such as: black cod, red snapper, flounder ling cod, rockfish, sole and true cod. Figure I illustrates the landings in millions of pounds for the period 1935-1973. Also present is the poundage for salmon showing its relative importance to the total landings. Such illustrations do not indicate the relative values of the catches. For instance, the shark liver poundage is insignificant in the totals for any year during the ten (10) years they were taken however, their value was comparable to those of any other portion of the fishery. While in contrast the high poundage of bottom fish, much of it incidental catch with shrimp, of 1973 is a very low value.

The graph shows long term trends and the wide variation in catch. The ocean catch other than salmon is important to the bay fishery in that it tends to extend seasons in the bay by supplying fishermen and processors income between the seasons of major fishery within the bay. The bay is closely related to the ocean fishery in that it acts as a nursery for the majority of the commercial fish species taken there and feed for some species after they mature in the ocean for instance the large amounts of herring and anchovy produced in the bay.

FISH TRAPS

Commercial fishing for salmon was one of the original industries in Willapa Bay. Species considered as salmon at that time were chinook, silver, sockeye, pink, chum and steelhead. Legal fishing gear consisted of pound nets, setnets, gillnets, occasionally seines and hook and lines. Pound nets (traps) and setnets were fixed in position while the others were moveable gear.

Rights to fishing locations for fixed gear, traps and setnets, were originally acquired by occupation of the site and maintaining claim piling when the trap or net was not in place. The 1915 legislature formalized the rights to fishing locations in Willapa Bay. In order to insure his rights to a location, a fisherman was required to have the site accurately surveyed by a Civil Engineer, make a location map to identify the site, prepare a certificate claiming the location and file the map and certificate with the County Auditor and a duplicate with the Fish Commissioner. This process gave the fishermen exclusive rights to hold and occupy the location. The location

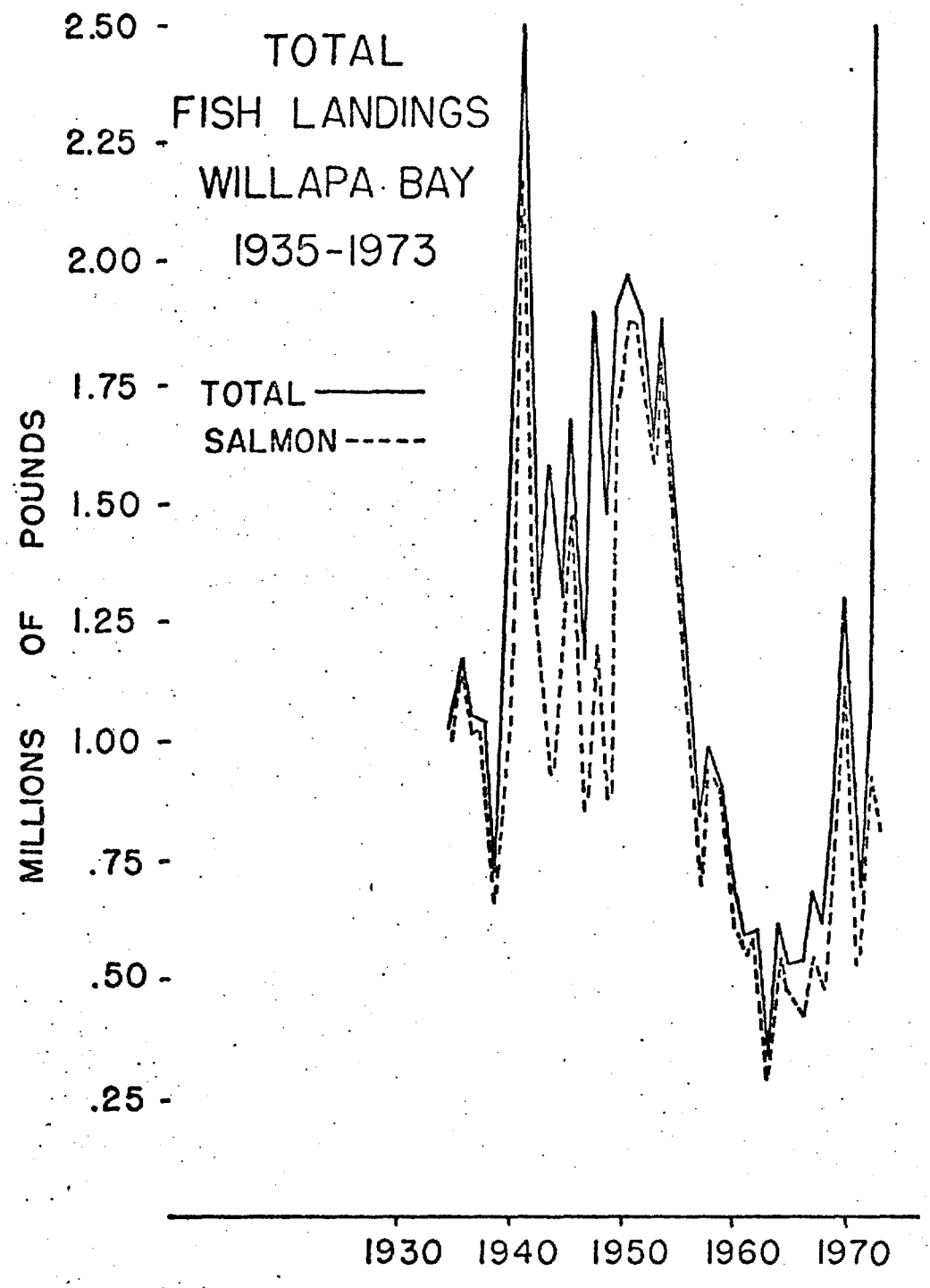

TOTAL
FISH LANDINGS
WILLAPA BAY
1935-1973
TOTAL ——
SALMON -----
MILLIONS OF POUNDS
2.50
2.25
2.00
1.75
1.50
1.25
1.00
.75
.50
.25
1930
1940
1950
1960
1970

FIGURE 1

FINFISH LANDINGS WILLAPA BAY

IN POUNDS TABLE 1

YEAR	SALMON	STURGEON	SHARK L.	SMELT	ANCHOVY	ALBACORE	BOTTOM FISH	TOTAL
1935	1,017276							1,017,276
1936	1,145,181	38,274						1,183,455
1937	1,024,285	41,224						1,065,509
1938	1,032,879	12,025						1,044,904
1939	661,881	12,958			7,145			681,984
1940	982,619	5,434		170,600				1,158,653
1941	1,729,904	1,634		198,725		149		1,930,412
1942	2,508,988	3,762	246			83,088	380	2,596,464
1943	1,233,116	233	31,719			2,849		1,267,917
1944	927,616	14,037	40,110	8,375		533,727	57,515	1,581,380
1945	1,097,222	13,480	52,814			126,598	18,232	1,308,346
1946	1,472,857	24,396	70,379			92,256	10,460	1,670,348
1947	849,557	9,630	31,645			244,460	20,665	1,155,957
1948	1,206,771	9,479	23,395		436,700	179,167	56,048	1,911,560
1949	886,066	9,788	4,525		448,781	112,222	12,881	1,474,263
1950	1,673,555	15,573	1,554			218,346	3,045	1,912,073
1951	1,875,111	27,927				76,509	1,008	1,980,555
1952	1,852,586	32,166	935			17,780	1,406	1,904,873
1953	1,581,397	34,154	744			513	301	1,617,109
1954	1,849,490	17,007	390				10,091	1,876,978
1955	1,439,978	22,281			570		1,763	1,464,592
1956	1,061,501	73,939				2,457	87	1,137,984
1957	735,081	20,353					9,931	765,365
1958	935,304	15,944				2,323	34,757	988,328
1959	887,215	23,502				6,522	3	917,242
1960	667,037	37,153						704,190
1961	543,284	47,075					72	590,431
1962	581,299	21,610			100			603,009
1963	295,280	29,980				2,923		328,183
1964	559,703	38,401				1,304		599,408
1965	473,330	32,289				16,115		521,734
1966	422,137	76,420				33,621		532,178
1967	553,489	88,364				43,350		685,203
1968	477,652	75,917				50,818		604,387
1969	773,249	109,313				9,384		891,946
1970	1,160,490	139,627						1,300,117
1971	538,395	143,301				8,513	3,715	682,003
1972	942,158	95,604				30,684	2,705	1,065,895
1973	1,460,284	69,031					1,730,710	2,546,532
1974	826,187	53,382				28,055		

BOTTOM FISH INCLUDE: BLACK COD, FLOUNDER, LING COD, ROCK FISH, SOLE, TRUE COD

became an item of real property which could be transferred to heirs or successors. It could be mortgaged, sold or leased. The 1911 legislature declared fishing locations personnal property for purposes of taxation. Figure 2 is an example of a claim document. When the fishing right was established and the fishing license obtained it was then necessary to apply to the Army Corps of Engineers for a permit to construct the trap at the location. A copy of a permit is shown in Figure 3.

A license to operate the trap was necessary for each season. The rights to the fishing location could be lost by not making use of the site. The location was considered to be abandoned if the trap was not constructed or a license not obtained. The time involved varied. The 1897 legislature declared that if the trap were not built during the season covered by license it was abandoned. The 1915 legislature extended the time to two consecutive seasons and the 1929 legislature extended the time to four years. No more than three licenses could be held by any person, firm or corporation. The numbers of pound net and setnet location permits issued for Willapa Bay each year are presented in Table 2.

Traps in Willapa Bay could not exceed 800 feet in length. The lateral passage between traps was 900 feet and the end passage between traps was 30 feet. Meshes in nets used in constructing pound nets could be no smaller than three inches. Traps could extend no more than half the way across a stream, channel or slough until 1899 when the legislation was changed, reducing this distance to one third. The piling of the trap extended above high water and the trap had a light at night as an aid to navigation.

Figure 4 illustrates the basic design of traps used on Willapa Bay and Figure 5 shows typical placements of the traps in streams and channels. Figure 6 outlines areas in the Bay in which traps and setnets were used between 1915 and 1935. Five hundred and fifty three claims for fishing locations were filed and completed for Willapa Bay between 1915 and 1935. The distribution of these claims in specific areas is shown in Figures 7, 8, 9 and 10. It may be seen that between the two time periods represented by the maps, 1915-1920 and 1925-1930, that the fishing locations for the trpas moved down river in the Naselle and Willapa and out onto the flats of Bear River and Nemah utilizing the channels in the flats.

Production by species and gear between 1915 and 1935, when fixed gear was outlawed, is illustrated in the graphs of Figures 11 and 12. Those graphs indicate the number of licenses for each type of gear and the production from each by species. The low period in the early 20's which appears on all the graphs apparently is reflective of the depressed canned salmon market following World War I when a large surplus developed. It is also apparent from the graphs that production generally parallels the amount of gear. Another obvious conclusion is that pound nets (traps) were particularly effective in catching chum salmon. Pound nets, fish traps, fish wheels, scow fish

TABLE 2

FISH LOCATIONS

WILLAPA BAY - PERMIT FILINGS BY YEAR

AUDITORS NO.	YEAR	NUMBER FILED
4-222	1915	79
223-225	1916	3
226-249	1917	23
250-271	1918	23
272-277	1919	6
278-291	1920	15
349-354	1924	4
365-413	1925	14
415-560	1926	96
561-713	1927	116
714-794	1928	37
798-879	1929	36
885-929	1930	14
--	1931	0
983-986	1932	4
1034-1072	1933	34
1073-1094	1934	8

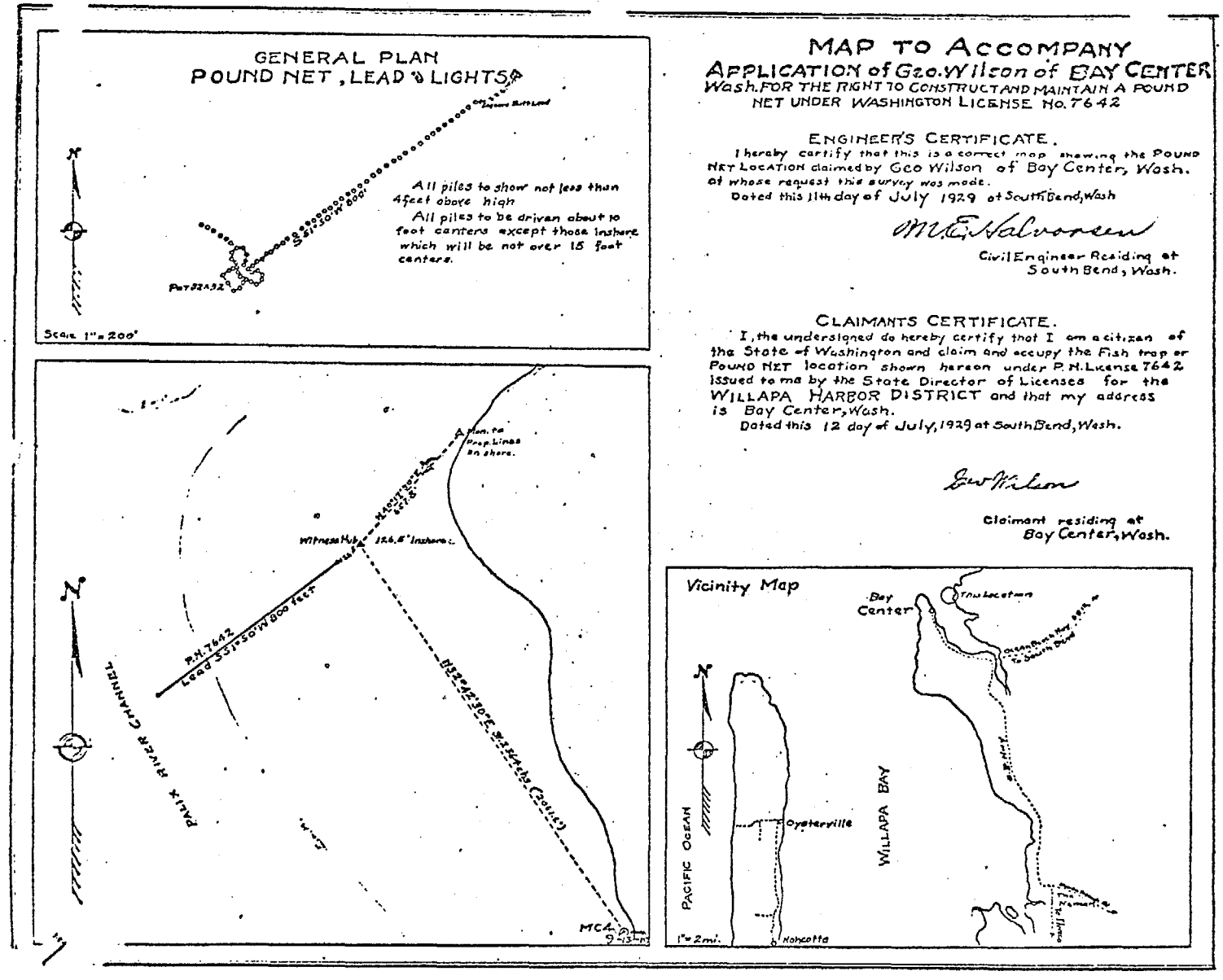

GENERAL PLAN
POUND NET, LEAD & LIGHTS
All piles to show not less than 4 feet above high
All piles to be driven about 10 feet centers except those inshore which will be not over 15 feet centers.
Scale 1" = 200'
Witness Hub
126.6' Inshore
P.H.7642
Lead 55°30'W 800 feet
PALIX RIVER CHANNEL
MAP TO ACCOMPANY
APPLICATION of Geo. Wilson of BAY CENTER Wash. FOR THE RIGHT TO CONSTRUCT AND MAINTAIN A POUND NET UNDER WASHINGTON LICENSE No. 7642
ENGINEER'S CERTIFICATE.
I hereby certify that this is a correct map showing the POUND NET LOCATION claimed by Geo Wilson of Bay Center, Wash. at whose request this survey was made.
Dated this 11th day of July 1929 at South Bend, Wash
M. E. Halvorsen
Civil Engineer Residing at South Bend, Wash.
CLAIMANTS CERTIFICATE.
I, the undersigned do hereby certify that I am a citizen of the State of Washington and claim and occupy the Fish trap or POUND NET location shown hereon under P. H. License 7642 issued to me by the State Director of Licenses for the WILLAPA HARBOR DISTRICT and that my address is Bay Center, Wash.
Dated this 12 day of July, 1929 at South Bend, Wash.
Geo Wilson
Claimant residing at Bay Center, Wash.
Vicinity Map
Bay Center
Oysterville
PACIFIC OCEAN
WILLAPA BAY
Nahcotta
1" = 2 mi.

FIGURE 2

UNITED STATES ENGINEER'S OFFICE
SEATTLE, WASHINGTON

September 4, 1924. 191

Mr. Walter Williams,

South Bend, Wash.

Sir,

Referring to your Application of Aug. 14, 1924 for authority to construct and maintain a fish trap under State fishing license No. 4153 dated Aug. 13, 1924, at Mouth of North Nemah River channel,

as shown on the map attached hereto, I have to advise you that under the provisions of section 10 of the river and harbor act, approved March 3, 1899, you are authorized by the Secretary of War to construct and maintain the fish trap, subject to the following conditions:

CONDITIONS.

1. That this authority does not give any property rights either in real estate or material, or any exclusive privileges; and that it does not authorize any injury to private property or invasion of private rights, or any infringement of Federal, State or local laws or regulations, nor does it obviate the necessity of obtaining State assent to the work authorized. IT MERELY EXPRESSES THE ASSENT OF THE FEDERAL GOVERNMENT SO FAR AS CONCERNS THE PUBLIC RIGHTS OF NAVIGATION. (See Cummings vs. Chicago, 188 U. S., 410).

2. That all the apparatus used and the work herein authorized shall be subject to the supervision and approval of the Engineer Officer of the United States Army in charge of the locality, who may temporarily suspend the work at any time if, in his judgment, the interests of navigation so require.

3. That the trap shall not be located or built in such place or manner as to unreasonably obstruct or interfere with navigation.

4. That on the outer end of the trap the grantee or owner shall maintain a sign inscribed with the State license number in numerals not less than six inches in height, capable of being readily read from passing vessels, and failure to keep such sign conspicuously displayed shall be sufficient reason for the cancellation of this authority and for prosecution as provided in the next paragraph. All renewals of the State license shall be reported to the aforesaid Engineer Officer when they occur, together with the State license number. All changes of ownership shall also be reported to him immediately and this authority returned to him for proper notation thereon of such changes.

5. That upon the abandonment of the location or upon ceasing to use the trap as hereby authorized, this instrument of authority and the map or maps attached thereto shall be immediately returned to the aforesaid Engineer Officer together with notice of the abandonment, and the owner shall immediately remove the structure at his own expense, including all piling, stakes, etc., to the satisfaction of the aforesaid Engineer Officer. Failure to so remove the same shall be considered good ground for prosecution of the grantee or owner for maintaining an illegal structure endangering navigation, as set forth in sections 10 and 12 of the river and harbor act of March 3, 1899. PROVIDED, that if the use of said structure is suspended temporarily, it may be maintained in whole or in part if the license number is conspicuously displayed and the trap is properly lighted or otherwise marked as may be necessary to prevent unreasonable obstruction to navigation. Any fish weir, trap or pound, allowed to go into a condition of disrepair so that it cannot be readily seen, or on which the license number is not conspicuously displayed, will be regarded as abandoned, and if not promptly removed or marked as above provided will subject the grantee or owner to prosecution, and any trap not in use on which the license number is not displayed will be subject to removal by the United States at any time.

6. That if future operations by the United States require an alteration in the position of the trap, or if the latter, in the opinion of the Secretary of War, shall cause unreasonable obstruction to the free navigation of the said waters, the grantee will be required, upon due notice from the Secretary of War and within thirty days thereafter, to remove or alter the trap, or obstruction caused thereby, without expense to the United States, so as to render navigation reasonably free, easy and unobstructed. No claim shall be made against the United States on account of such removals or alterations.

*7. That the trap shall be lighted between sunset and sunrise, by and at the expense of the grantee, for the safety of navigation. The light shall be displayed at ~~each end~~ the outer end ~~of the structure~~ and at an elevation of not less than sixteen feet above high water. The ~~outer~~ light shall be white, ~~the inner light shall be red~~, and ~~their~~ shall be equal to an eight inch ship's anchor light, with a capacity to burn eight day. S. unattended. ~~They~~ It shall be subject to the inspection of the aforesaid Engineer Officer before use.

8. That there shall be installed and maintained on the trap, by and at the expense of the grantee, such additional lights and signals as may be prescribed by the Bureau of Lighthouses, Department of Commerce, and that provision shall be made, by watchman or otherwise, for proper attendance of lights and signals, so that they will at all times be in effective condition.

9. That this authority is revocable at will by the Secretary of War, and unless previously revoked under paragraph (6) above shall cease and be null and void March 31, 1928.

By authority of the Secretary of War:

W. H. Bixby
Lt. Col. Corps of Engineers, U. S. Army.

Attached.
1 Blueprint.

*Additions to be made to this condition and superfluous words to be stricken out as may be necessary to provide for lighting the particular structure in accordance with the provisions of the regulation approved by the Department of Commerce, June 19, 1913.

FIGURE 3

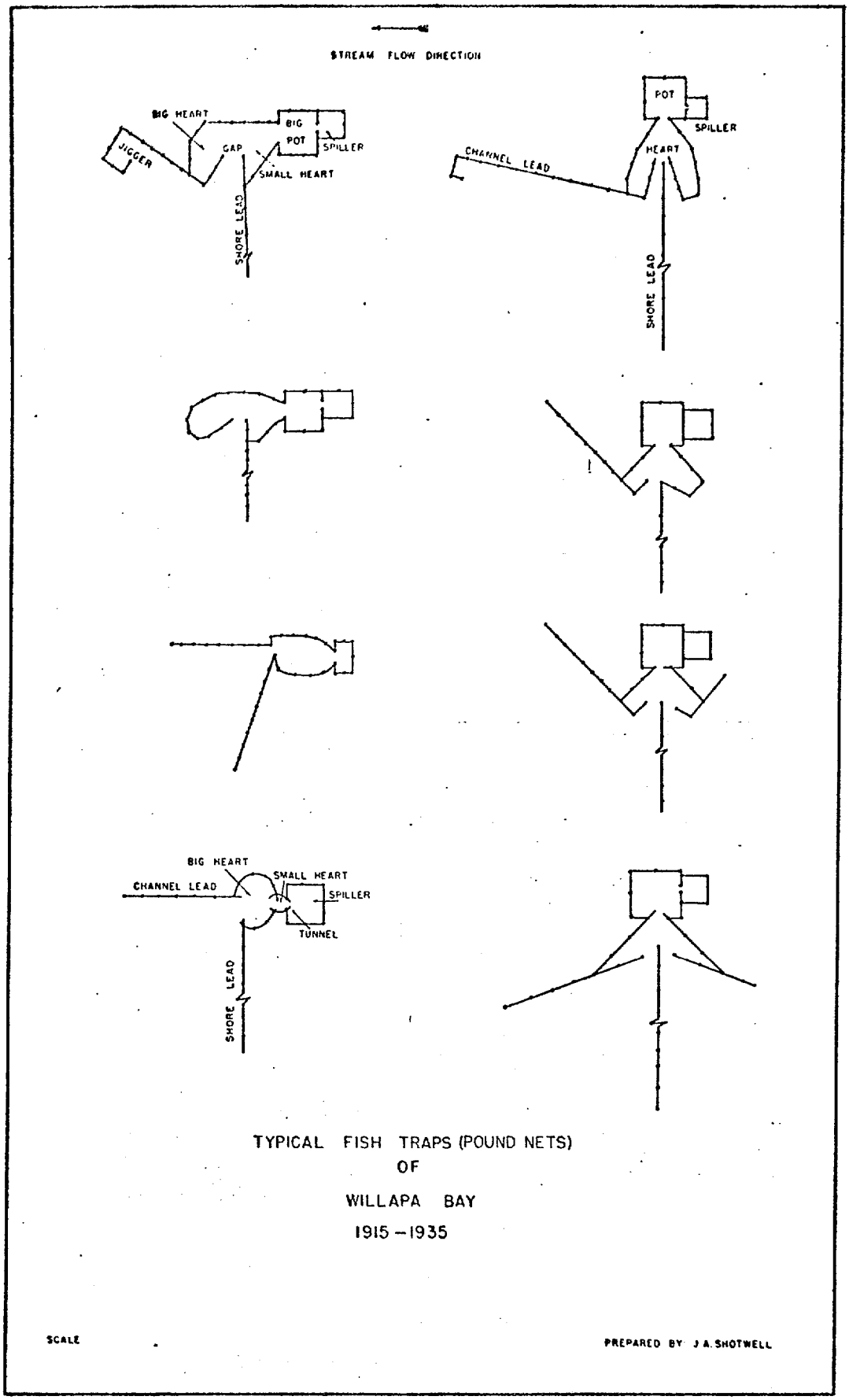

STREAM FLOW DIRECTION
BIG HEART
BIG POT
SPILLER
JIGGER
GAP
SMALL HEART
SHORE LEAD
POT
SPILLER
CHANNEL LEAD
HEART
SHORE LEAD
BIG HEART
SMALL HEART
CHANNEL LEAD
SPILLER
TUNNEL
SHORE LEAD
TYPICAL FISH TRAPS (POUND NETS)
OF
WILLAPA BAY
1915 – 1935
SCALE
PREPARED BY J.A. SHOTWELL

FIGURE 4

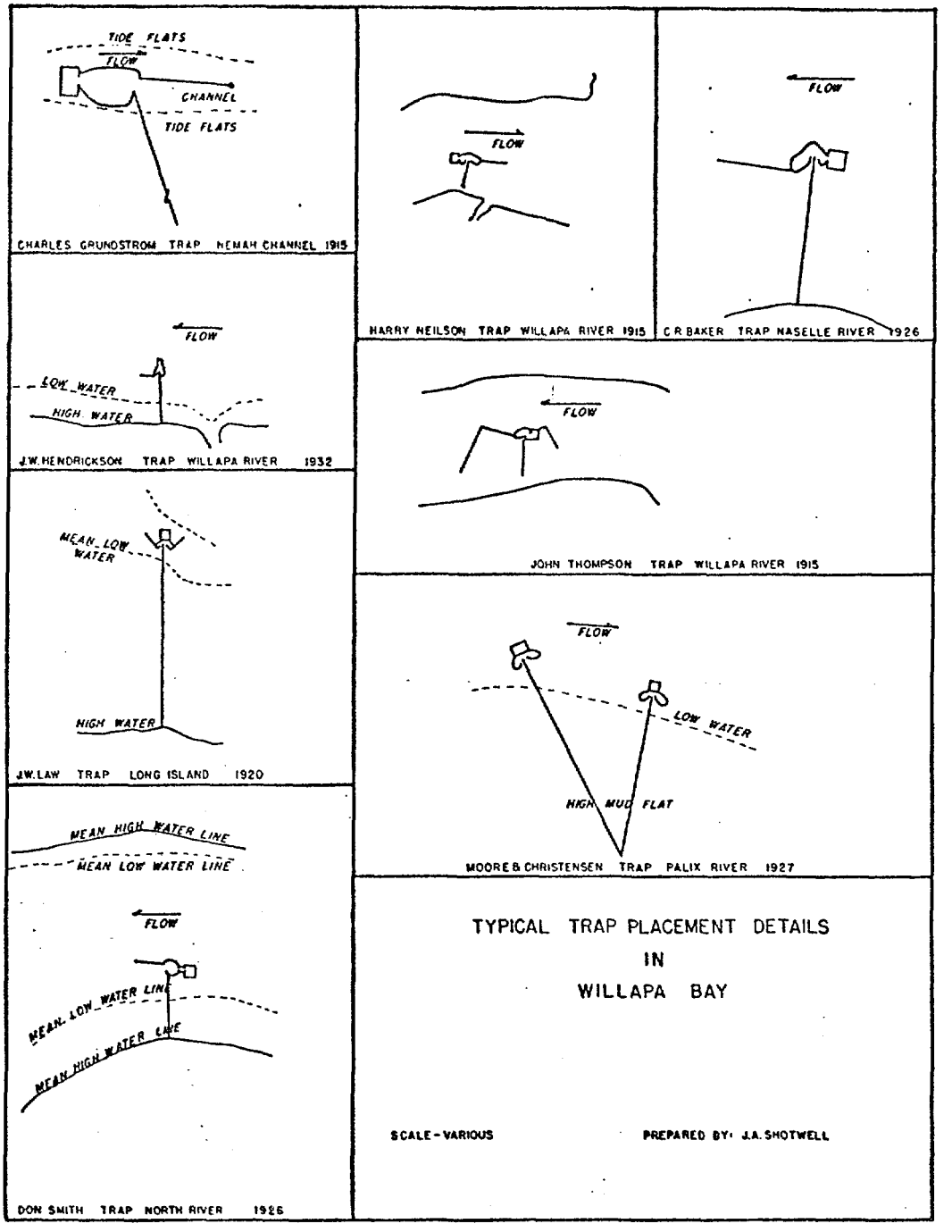

TIDE FLATS
FLOW
CHANNEL
TIDE FLATS
CHARLES GRUNDSTROM TRAP NEMAH CHANNEL 1915
FLOW
HARRY NEILSON TRAP WILLAPA RIVER 1915
FLOW
C R BAKER TRAP NASELLE RIVER 1926
FLOW
LOW WATER
HIGH WATER
J.W. HENDRICKSON TRAP WILLAPA RIVER 1932
FLOW
JOHN THOMPSON TRAP WILLAPA RIVER 1915
MEAN LOW WATER
HIGH WATER
J.W. LAW TRAP LONG ISLAND 1920
FLOW
LOW WATER
HIGH MUD FLAT
MOORE & CHRISTENSEN TRAP PALIX RIVER 1927
MEAN HIGH WATER LINE
MEAN LOW WATER LINE
FLOW
MEAN LOW WATER LINE
MEAN HIGH WATER LINE
DON SMITH TRAP NORTH RIVER 1926
TYPICAL TRAP PLACEMENT DETAILS
IN
WILLAPA BAY
SCALE - VARIOUS
PREPARED BY: J.A. SHOTWELL

FIGURE 5

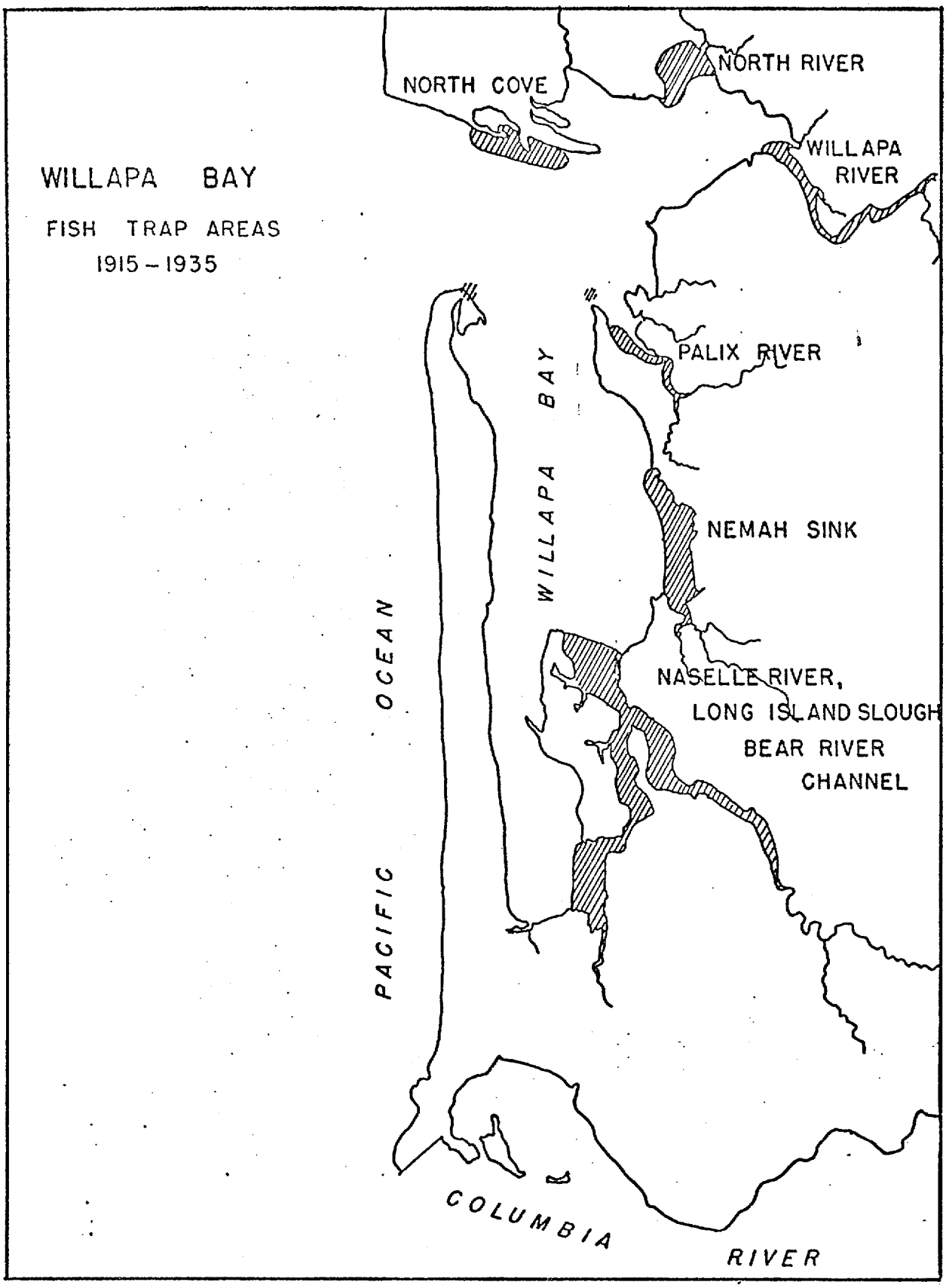

WILLAPA BAY
FISH TRAP AREAS
1915 – 1935
NORTH COVE
NORTH RIVER
WILLAPA RIVER
PALIX RIVER
WILLAPA BAY
NEMAH SINK
NASELLE RIVER,
LONG ISLAND SLOUGH
BEAR RIVER
CHANNEL
PACIFIC OCEAN
COLUMBIA RIVER

FIGURE 6

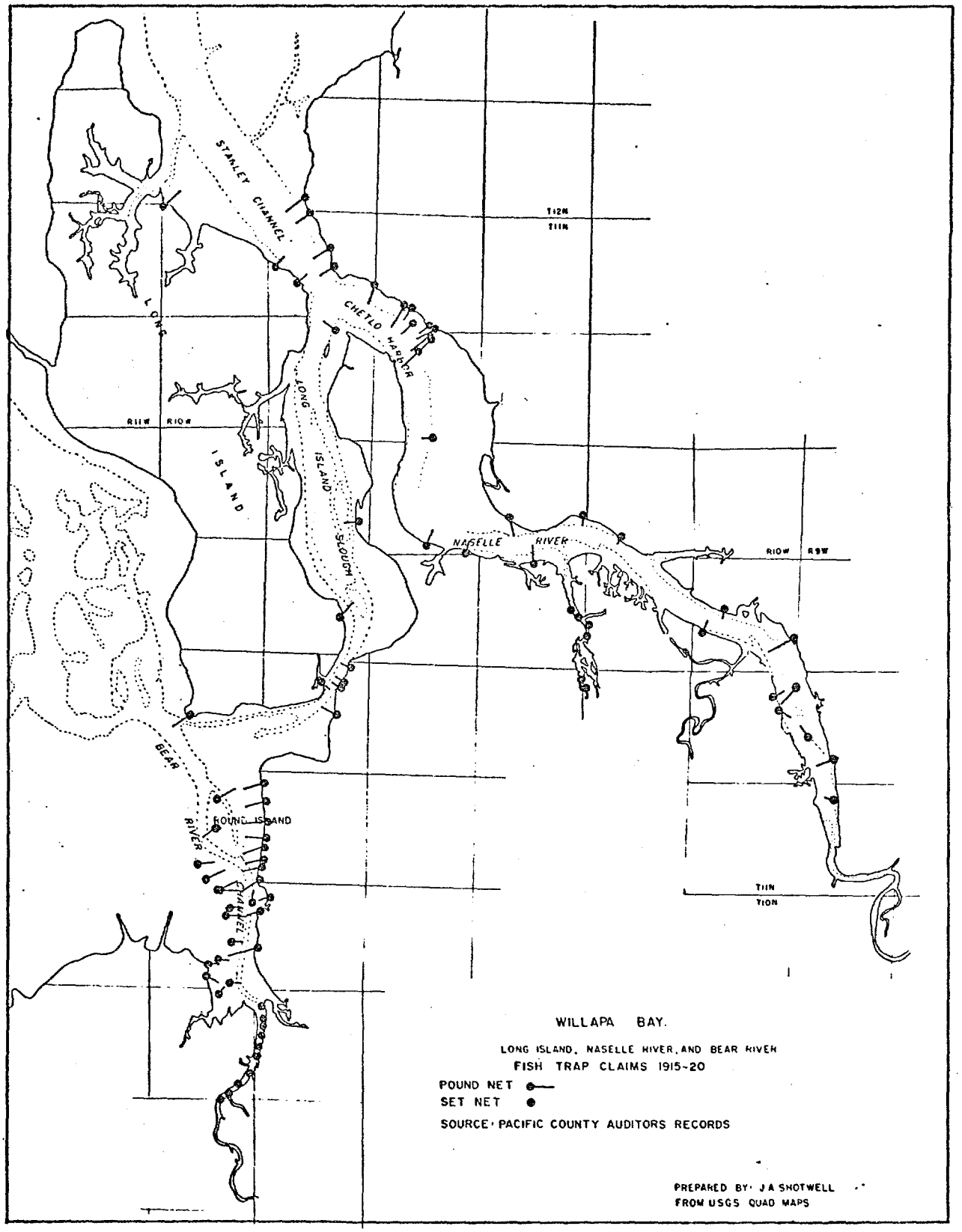

STANLEY CHANNEL
LONG
CHETLO HARBOR
LONG ISLAND SLOUGH
ISLAND
NASELLE RIVER
BEAR RIVER
ROUND ISLAND
CHANNEL
T12N
T11N
R11W
R10W
R10W
R9W
T11N
T10N
WILLAPA BAY.
LONG ISLAND, NASELLE RIVER, AND BEAR RIVER
FISH TRAP CLAIMS 1915-20
POUND NET
SET NET
SOURCE: PACIFIC COUNTY AUDITORS RECORDS
PREPARED BY: J A SHOTWELL
FROM USGS QUAD MAPS

FIGURE 7

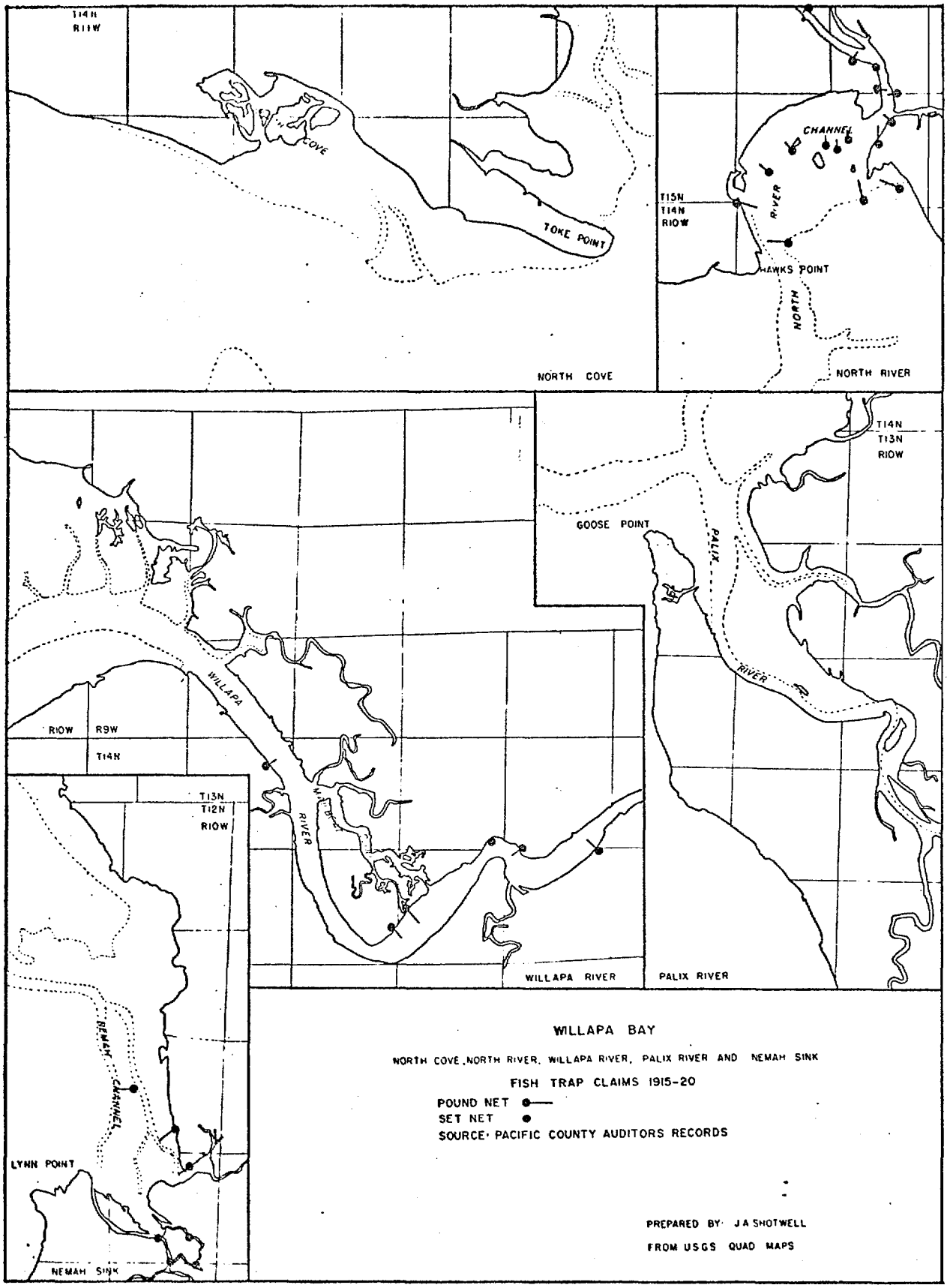

T14N
R11W
COVE
TOKE POINT
NORTH COVE
CHANNEL
T15N
T14N
R10W
RIVER
HAWKS POINT
NORTH
NORTH RIVER
T14N
T13N
R10W
GOOSE POINT
PALIX
RIVER
R10W
R9W
T14N
WILLAPA
RIVER
WILLAPA RIVER
PALIX RIVER
T13N
T12N
R10W
NEMAH CHANNEL
LYNN POINT
NEMAH SINK
WILLAPA BAY
NORTH COVE, NORTH RIVER, WILLAPA RIVER, PALIX RIVER AND NEMAH SINK
FISH TRAP CLAIMS 1915-20
POUND NET
SET NET
SOURCE: PACIFIC COUNTY AUDITORS RECORDS
PREPARED BY: J A SHOTWELL
FROM USGS QUAD MAPS

FIGURE 8

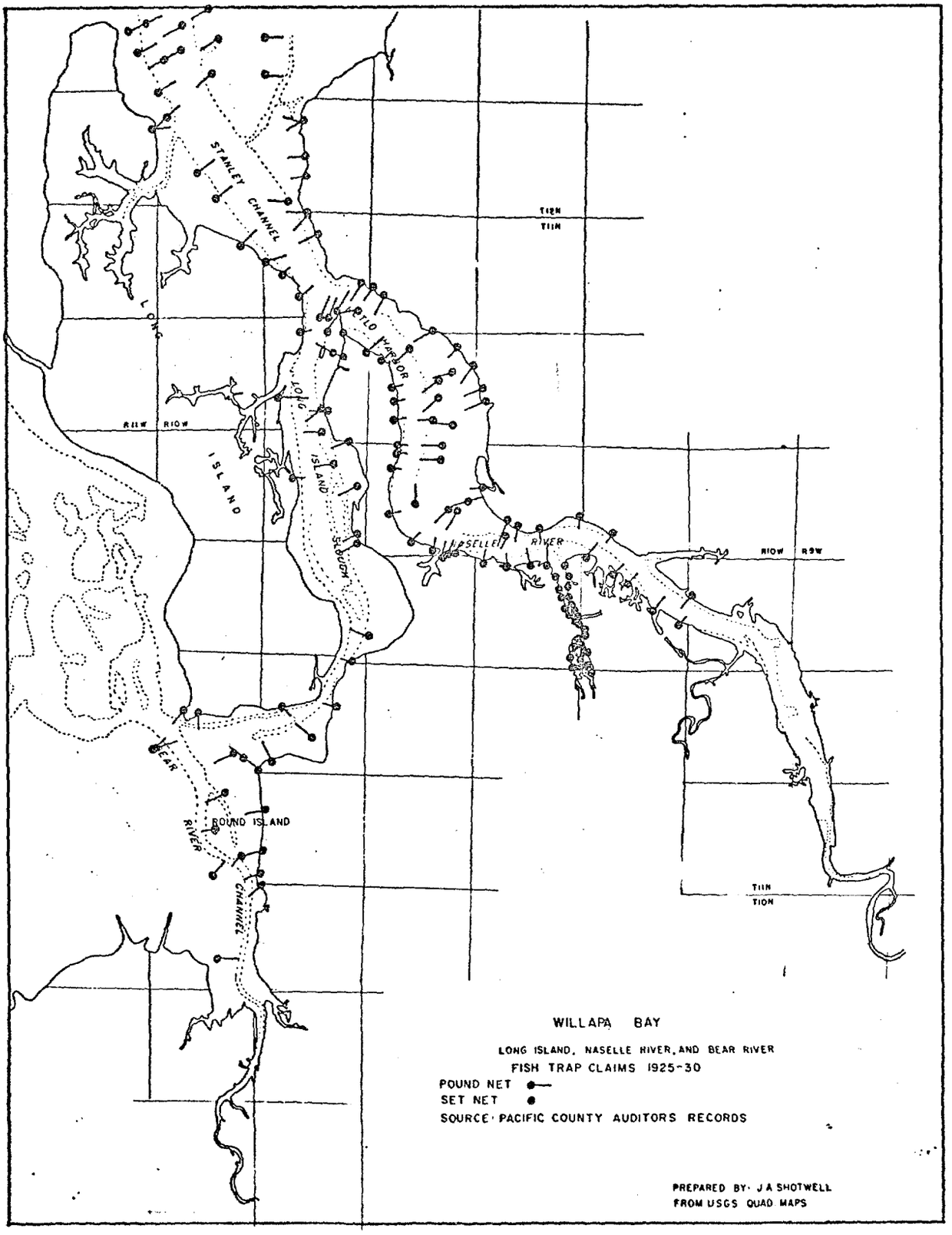

STANLEY CHANNEL
LONG ISLAND
OLD HARBOR
LONG ISLAND SLOUGH
NASELLE RIVER
BEAR RIVER
ROUND ISLAND
BEAR RIVER CHANNEL
T12N
T11N
R11W
R10W
R9W
T11N
T10N
WILLAPA BAY
LONG ISLAND, NASELLE RIVER, AND BEAR RIVER
FISH TRAP CLAIMS 1925-30
POUND NET
SET NET
SOURCE: PACIFIC COUNTY AUDITORS RECORDS
PREPARED BY: J A SHOTWELL
FROM USGS QUAD MAPS

FIGURE 9

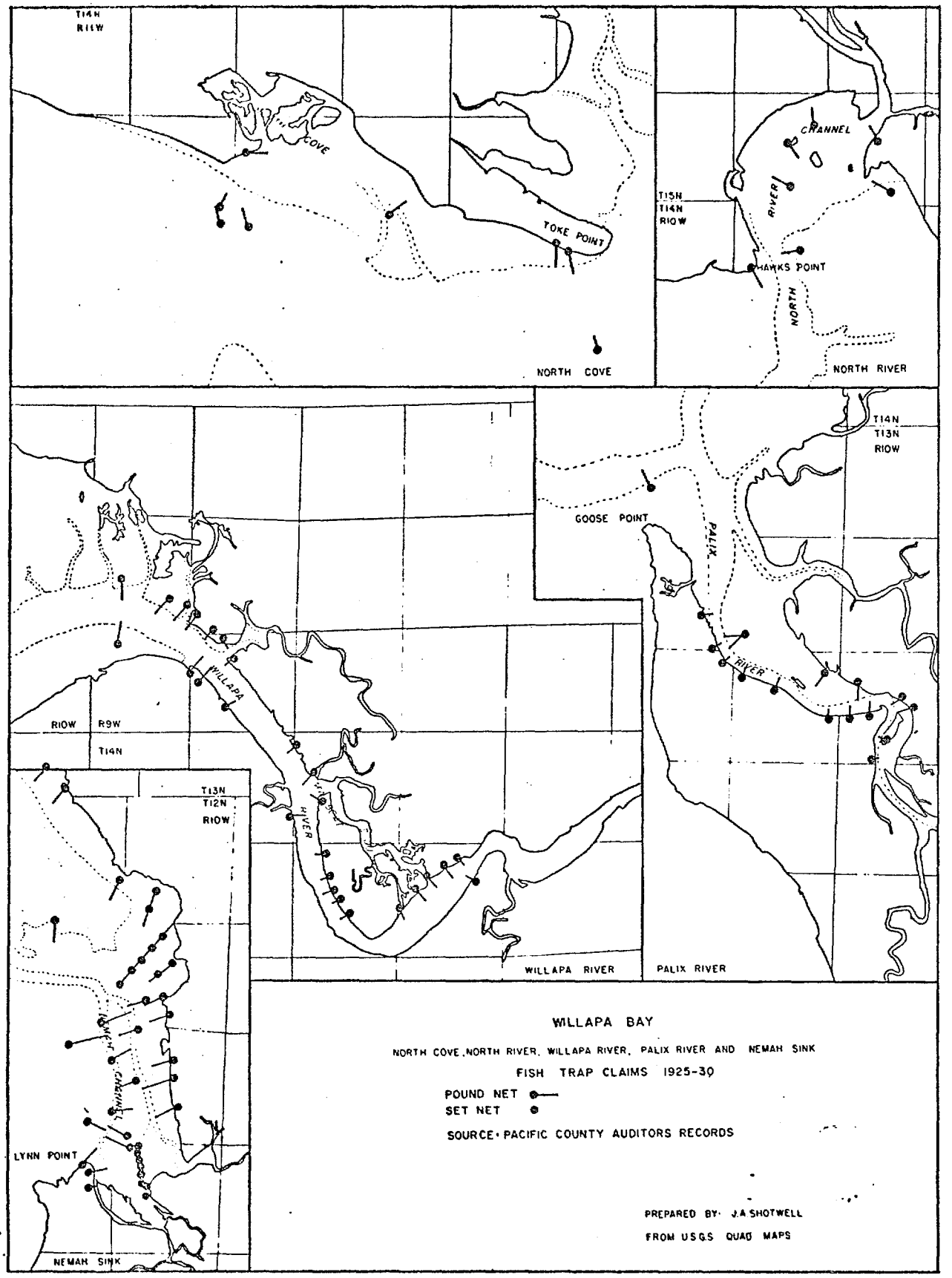

T14N
R11W
COVE
TOKE POINT
NORTH COVE
CHANNEL
RIVER
T15N
T14N
R10W
HAWKS POINT
NORTH
NORTH RIVER
T14N
T13N
R10W
GOOSE POINT
PALIX
RIVER
R10W
R9W
T14N
WILLAPA
RIVER
WILLAPA RIVER
PALIX RIVER
T13N
T12N
R10W
LYNN POINT
NEMAH SINK
WILLAPA BAY
NORTH COVE, NORTH RIVER, WILLAPA RIVER, PALIX RIVER AND NEMAH SINK
FISH TRAP CLAIMS 1925-30
POUND NET
SET NET
SOURCE: PACIFIC COUNTY AUDITORS RECORDS
PREPARED BY: J.A. SHOTWELL
FROM U.S.G.S. QUAD MAPS

FIGURE 10

wheels, setnets, weirs and all fixed applicances were outlawed by Initiative 77 which was approved in the 1934 general election. This action left gill nets as the primary fishing gear in Willapa Bay. The 1915 legislature limited gill nets to 1200 feet in length and thirty six meshes deep. It also limited gill net licenses for use in a single district.

Fish traps were for the most part locally owned and operated. Commonly two or more persons appear as holders of a location such as:

Guinn and Emerson
Newton and Shroyer
Williams and Ford
Howard and Prior
Harris and Pettit
Broughten and Lampi
H. E. and C. M. Jensen
O'Mera and Herrold
Swenney Brothers
Williams and Kline
Williams and Prickett
Fisher and Nelson
G. A. Mosher and Sons
Jensen and Mortneson
Moore and Christensen

Most of those combinations were probably operating partnerships. Packing companies also held fish trap locations such as:

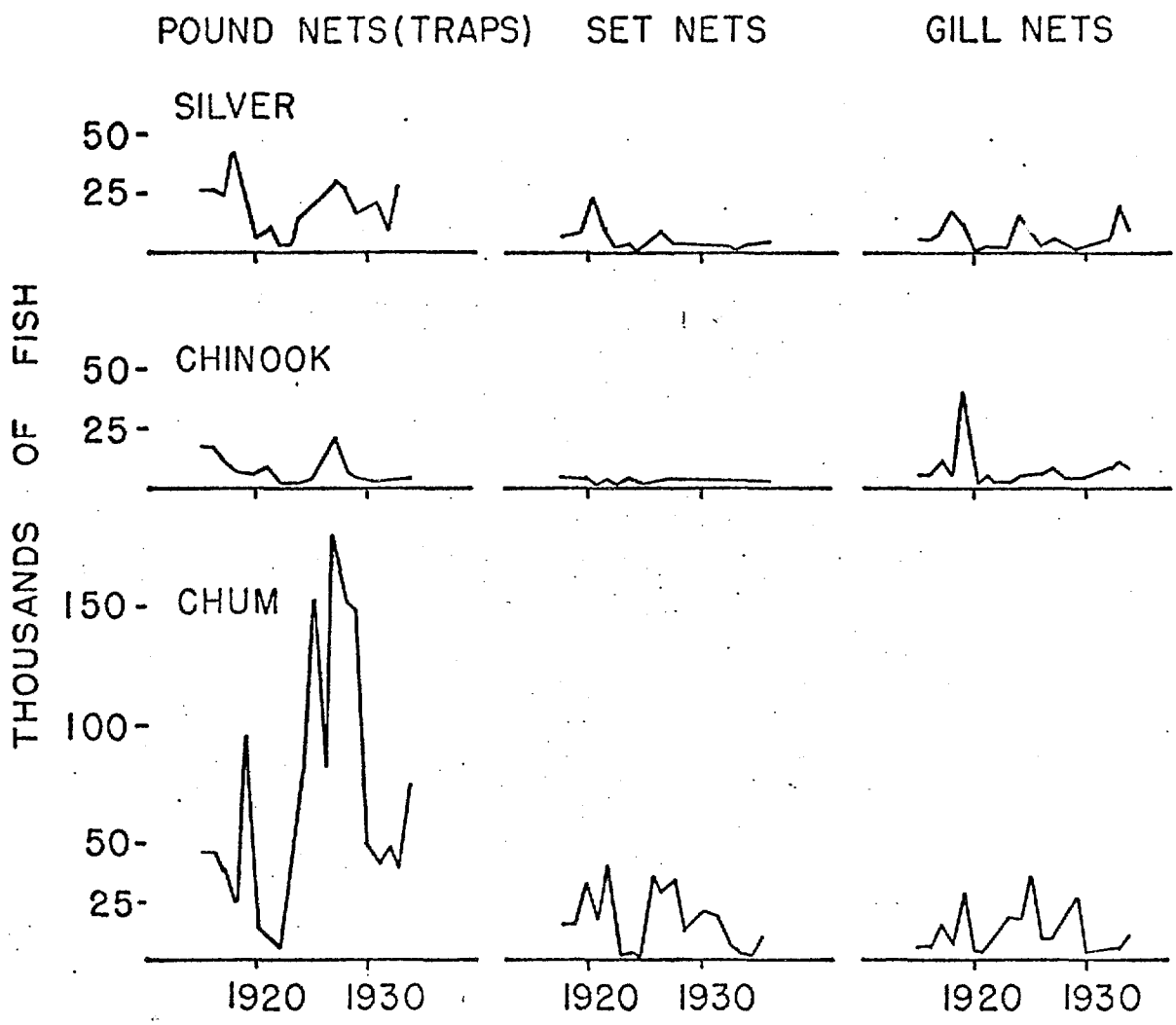
Pacific Fish Company
F. C. Barnes Co., later Barnes Packing Co.
Chinook Packing Company
Sunset Packing Company
Chetlo Packing Company
P. J. McGowan and Sons

These were local companies. Oystermen such as Wilson and Wiegardt and lumbercompanies such as Nicomen Boom Company held locations. There does not appear to have been any concentration of ownership in processors or absentee owners as was the case in Alaska.

The depletion of the fishery is not apparent until many years after traps and set nets were outlawed (See Figure 1 and 16). Gill nets increased in number and within ten years equalled in number the average of all gear for the twenty years prior to the removal of fixed gear from the fishery (See Figure 14). The primary result of the end to traps was to shift from a highly efficient system of harvesting to a less efficient one. The level of harvest was not changed until the number of fish was reduced with the decline of chum in the 1950's.

SEASONS AND FISHING AREAS

Fishing season was closed by the 1899 legislature from November 15 to December 15. The Fish Commissioner was given the authority to close the season at other times with a thrity day prior notice. The 1905 legislature changed the closed seasons to March 15 to April 15 and November 25 to December 25. The 1911 legislature changed the closed seasons to March 15 to April 15, August 1 to September 1 and December 5 to January 5. By 1915 the legislature had again changed the closure to March 15 through April 15 and December 1 through January 1 and allowed closure by the commissioner with fifteen days prior notice.

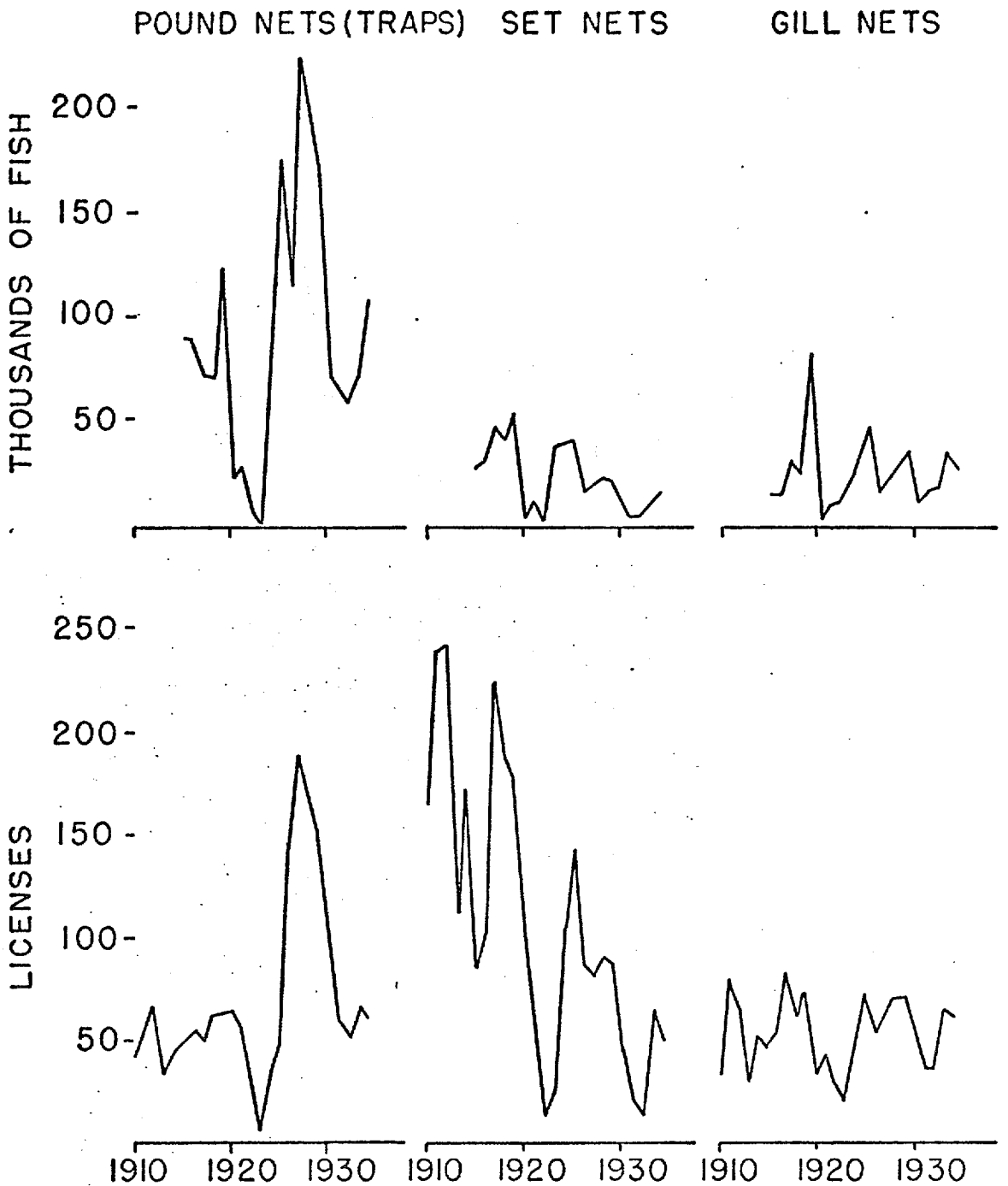


SALMON HARVEST WILLAPA BAY

1915 — 1935

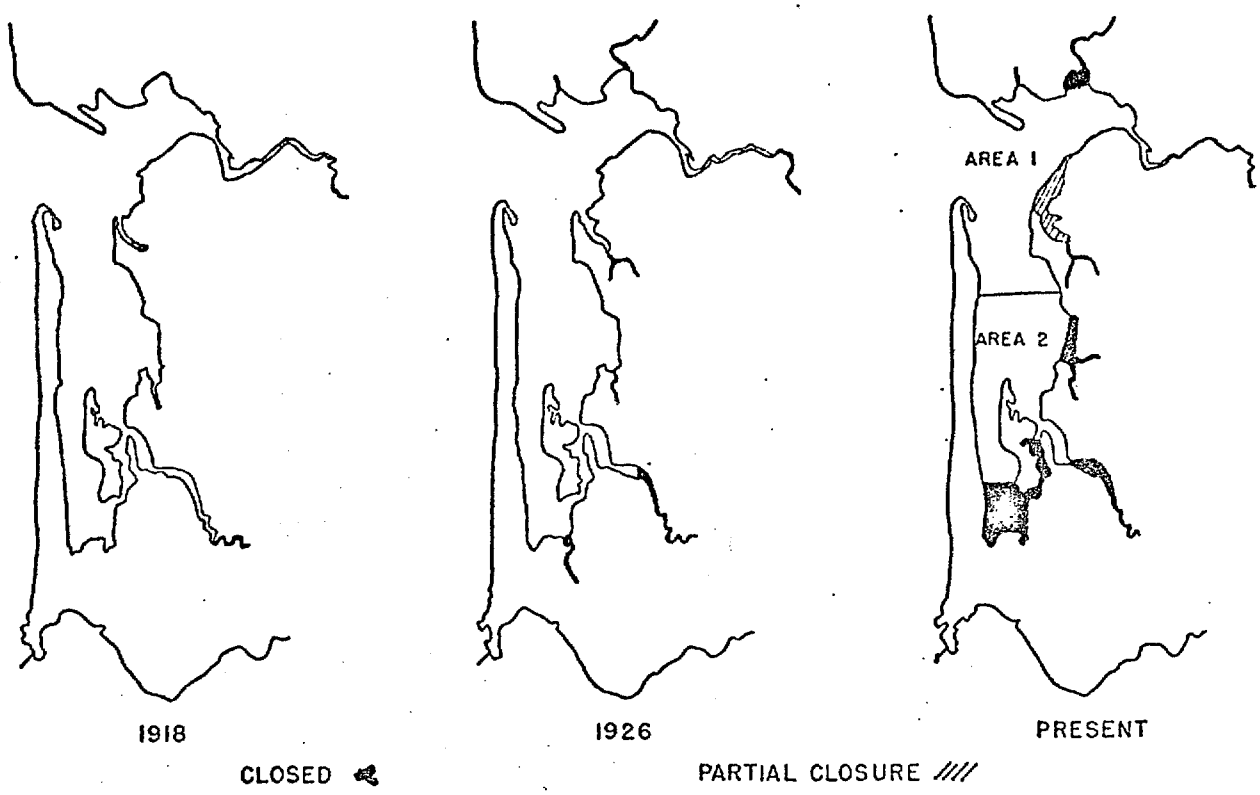
BY SPECIES AND GEAR

FIGURE 11



TOTAL SALMON HARVEST WILLAPA BAY
1915 — 1935
BY GEAR INCLUDING NUMBERS OF
LICENSES

FIGURE 12



FISHING AREAS WILLAPA BAY

FIGURE 13

After 1921 season closures as well as emergency closures were made by the fisheries department. The pattern in Willapa Bay has been to announce the season opening and closing date by director orders, usually July to October, then declare week-end closures followed by emergency closures based on the level of escapement. Regulation of the gill net season in Willapa Bay has then been based largely on the need to insure adequate salmon in the hatcheries and natural stream areas for propagation.

Deadlines were designated by the 1899 legislature as the limit of tide water in North River, Willapa River, and Naselle River. The 1911 legislature added the Palix, Nemah, and Bear Rivers. The 1915 legislature extended the deadlined streams to include the South Fork of the Willapa River, Cedar River, and Smith Creek. Tide water in the various rivers was designated as particular points on each of the streams. The 1917 legislature moved the North River deadline down stream from its earlier designation. As was the case for seasons, after 1921 the department of fisheries designated fishing areas. The Nemah flats were closed in 1958 to insure excapement to the Nemah hatchery built a few years earlier. The south bay was closed at about the same time to protect natural propagation in the Bear River. Figure 13 illustrates the reduction in fishing area from 1918 to 1974. During the period from 1918 to 1974 there has been a considerable reduction in fishing

time and area in Willapa Bay. Most of the area occupied by fixed gear during early harvest years in now closed, or as is the case of the Palix River, has a shorter season than other areas. The Naselle River below the Highway 101 bridge and much of the Willapa River which were in the active trap area, are still part of the commercial fishery.

LATER HARVEST

After 1935, salmon were taken only by gill net in Willapa Bay. The amount of gill net gear as indicated by licenses increased over the next ten years until the total compensated for the loss of fixed gear in the fishery (See Figure 14). Licenses provide an indication of the potential amount of legal gear in the bay fishery. However this is only true when gear is licensed for specific areas. The 1915 legislature created licensing districts. These were Puget Sound, Grays Harbor, Willapa Bay and the Columbia River. The later three included the adjacent ocean area. Under this system of districts gear could only be licensed in one district and licenses were transferable from one fishermen to another. Thus the number of licenses purchased indicated the potential amount of gear which might be used in the fishery. In 1949, the legislature eliminated districts and made gear licenses non-transferable. Apparently licensed gear could then be used in any of the former districts. No basis is thus available for estimating the potential gear that could be used in Willapa Bay under this arrangement. Fishermen from other areas could move to Willapa Bay if the season looked more promising there. The legislature again imposed a district system in 1957, but these districts, Grays Harbor, Willapa Bay and the Columbia River did not include the adjacent ocean area. A separate district was established for the ocean fishery at the same time. Licenses were still non-transferable but a fisherman could license gear from more than one district by paying three times the fee for a single district. After 1957 it is again possible to determine the potential legal gear that could be used in Willapa Bay. The 1971 legislature again changed the gear licensing districts by creating dual area districts. District one was Puget Sound. District two was a combination of Grays Harbor and Columbia River and District three Willapa Bay and Columbia River. This meant that gear licensed in district three could be fished in either the Columbia River or Willapa Bay. Licenses then do not give an indication of potential gear in the fishery under this arrangement.

The catch of the major species of salmon in Willapa Bay is illustrated by graphs in Figure 15. Chum salmon appears as the most abundant species with wide variations for many years varying from 50,000 to 200,000 fish. Originally a low value salmon, it has become more valuable but has also declined alarmingly in numbers seldom reaching 25,000 fish since 1960. Silver salmon has also varied greatly in catch but has not shown a major decline although the lows in the graph for the earlier 1960's were lower than previous lows. The silver is

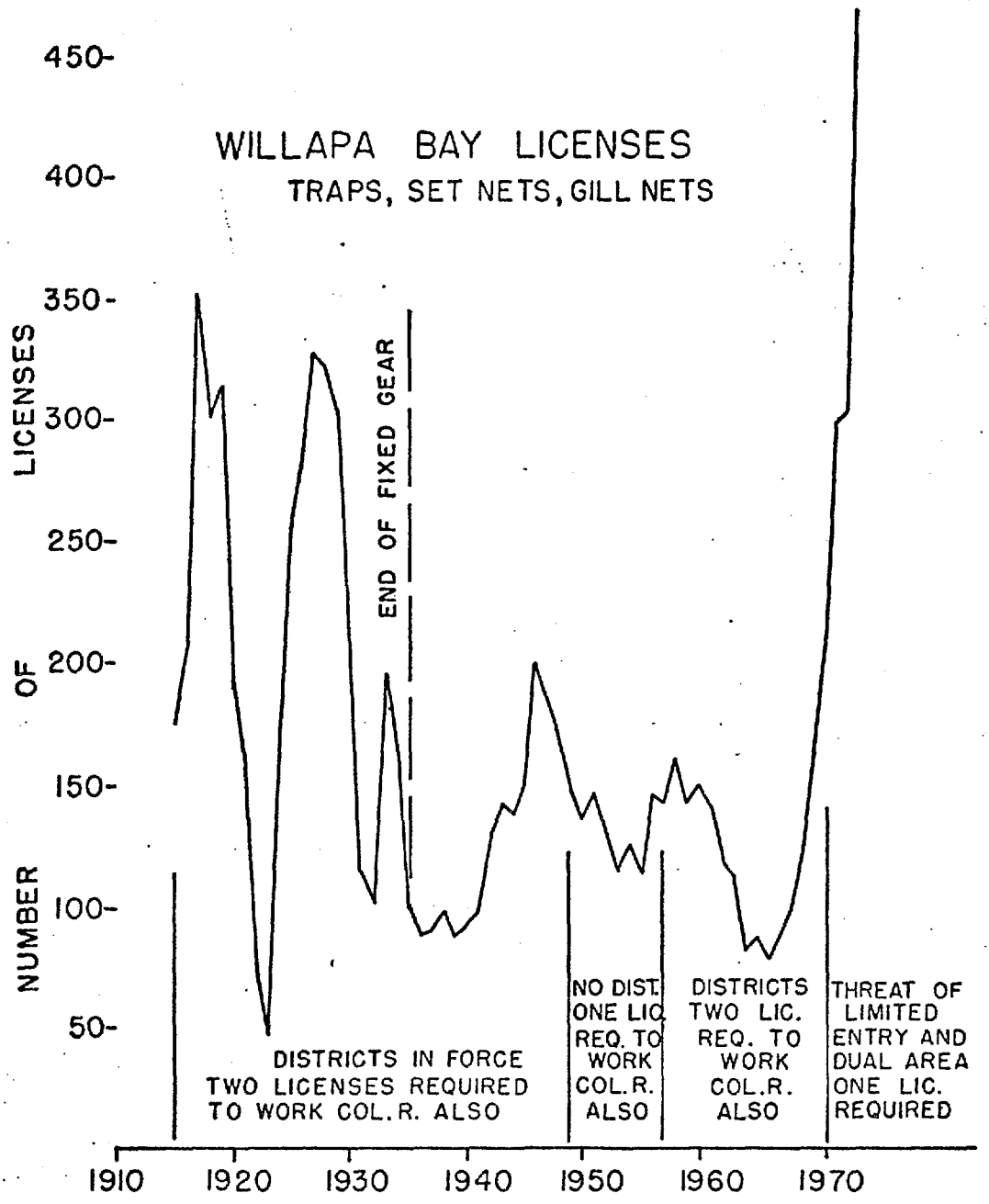

WILLAPA BAY LICENSES
TRAPS, SET NETS, GILL NETS
NUMBER OF LICENSES
450-
400-
350-
300-
250-
200-
150-
100-
50-
END OF FIXED GEAR
DISTRICTS IN FORCE
TWO LICENSES REQUIRED
TO WORK COL. R. ALSO
NO DIST. ONE LIC. REQ. TO WORK COL. R. ALSO
DISTRICTS TWO LIC. REQ. TO WORK COL. R. ALSO
THREAT OF LIMITED ENTRY AND DUAL AREA ONE LIC. REQUIRED
1910
1920
1930
1940
1950
1960
1970

FIGURE 14

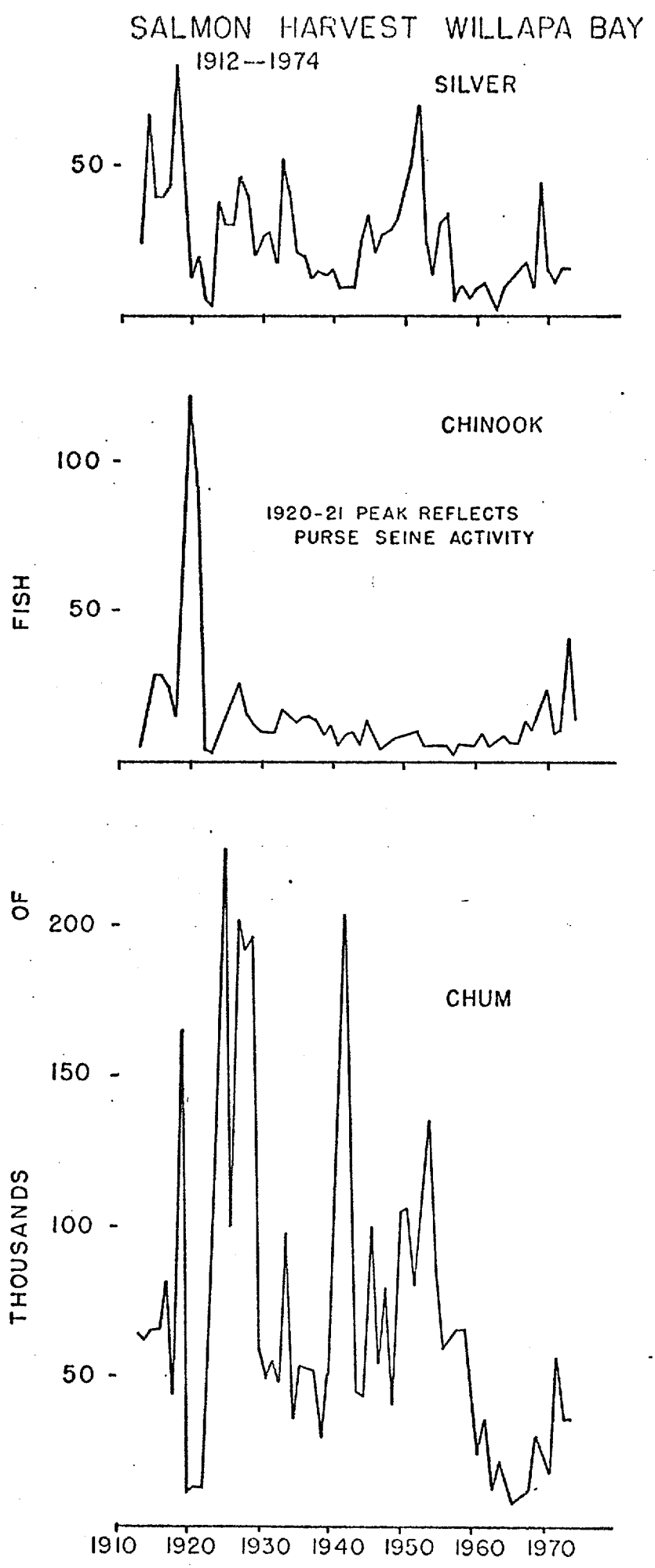

SALMON HARVEST WILLAPA BAY
1912--1974
SILVER
50 -
CHINOOK
100 -
1920-21 PEAK REFLECTS
PURSE SEINE ACTIVITY
50 -
FISH
OF
200 -
CHUM
150 -
THOUSANDS
100 -
50 -
1910 1920 1930 1940 1950 1960 1970

FIGURE 15

a more valuable salmon to the fisherman than chum, fish for fish, and is similar in size to the chum when it enters the Bay fishery. Chinook have not varied widely in numbers as have chum and to a lesser extent silver. They have usually been the lowest in numbers, seldom exceeding 10,000 fish, however they are much larger than either chum or silver and much more valuable on a per pound basis so that they are economically an important part of the catch.

FACTORS

Major factors effecting the catch in any particular year are; number of fish available, amount of gear in the fishery, fishing time and area available to the gear and price. The number of fish reflects the level of propagation, both artificial and natural of the brood years involved, predation, losses to the ocean fishery and other unknown factors. The amount of gear is influenced by the price of salmon, the success in adjacent fishing areas such as the Columbia River, which may be more attractive than the Willapa to fishermen at various times during the season. The nature of the fishermen themselves enters into the factor. Some are committed to fishing as major source of income augmenting their income with non-fishery employment only when the season is too poor to supply a minimum income while at the other extreme are the moonlighters whose primary source of income is some area other than the fishery but jump into the fishery during their off-time from their basic employment when the season appears to be good or the price of fish attractive. Since licenses must be purchased before the season starts they appear as having potential gear in the fishery. Fishing time is primarily regulated by the department of fisheries. A season is designated before fishing begins and then closed on an emergency basis or extended depending on the escapement of fish to the artificial (hatchery) and natural propagation areas. The number of fish in the run effects these decisions as well as stream flow conditions to the propagation areas or facilities. A dry year can reduce stream flows to a point fish will not move up to spawning grounds or hatcheries. Other factors limiting fishing time are storms which make fishing inadviseable, high abundance of sharks which foul nets, poor catches by other fisherman, high levels of phosphorescense in the water, etc. A wide variety of factors determines the amount of gear in the water any given season. The amount of gear licensed prior to the beginning of the season would appear to not directly indicate the actual fishing pressure but only the potential pressure on the fishery.

The total number of licenses purchased for gear in Willapa Bay for each of the years from 1915 to 1971 appears in the graph in Figure 14. It should be noted again that fixed gear (pound nets and set nets) became illegal in 1935 and this point is indicated on the graph.

Figure 16 presents graphically the total number of fish of all species of salmon taken each year in Willapa Bay from

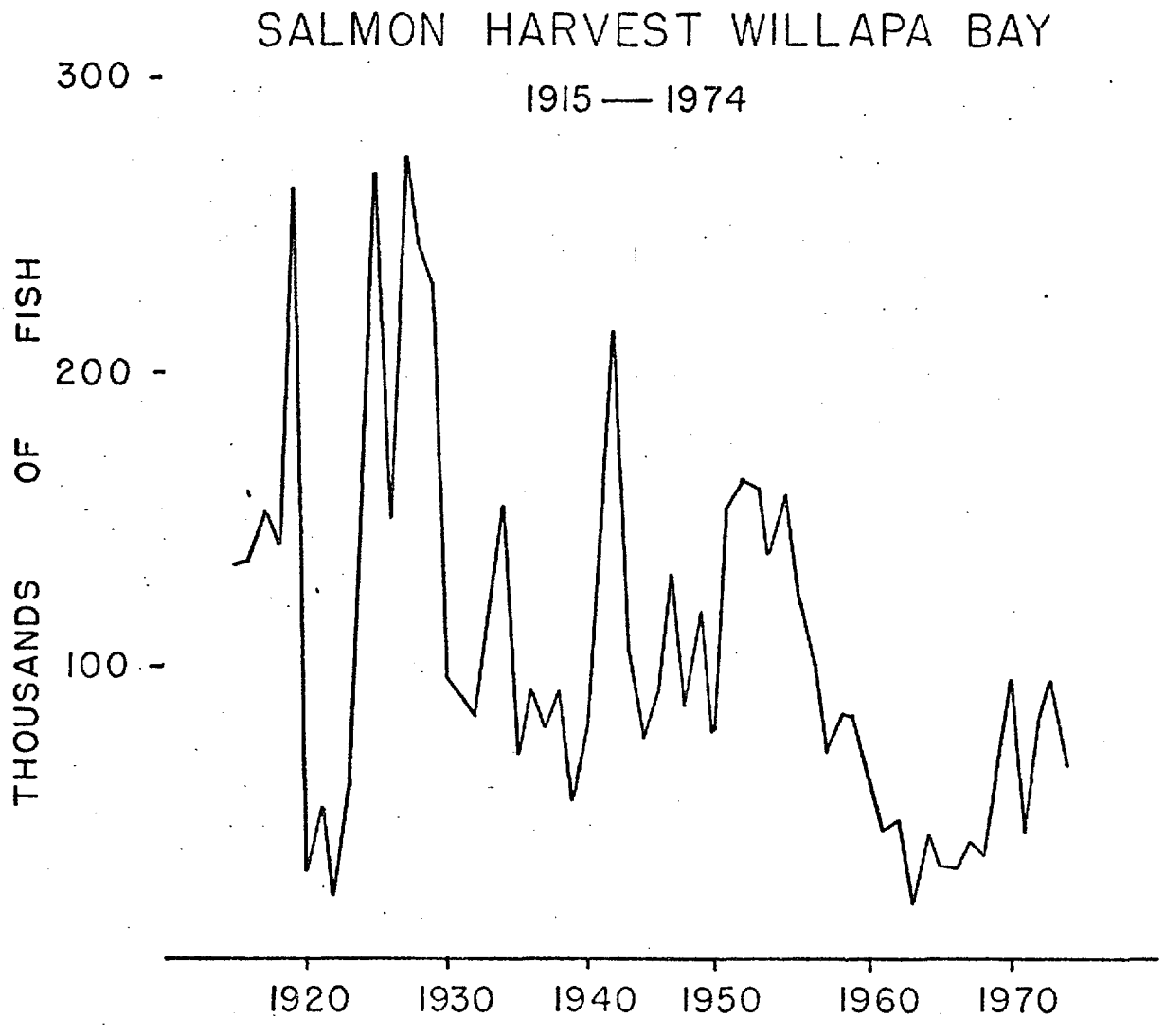

SALMON HARVEST WILLAPA BAY
1915 — 1974
300 -
200 -
100 -
THOUSANDS OF FISH
1920
1930
1940
1950
1960
1970

FIGURE 16

1915 to 1970. Comparison of the variation in amount of licensed gear with catch records (Figure 14 and 16) reveals than many of the peaks and lows appear at about the same time. This may be examined more directly by calculating a ratio of number of fish gear licenses to number of fish caught. Figure 17 presents graphically this ratio for the period 1915-1970. If the variation in gear and catch correlated exactly, the line of the ratios of fish to gear would be straight and horizontal. Upward divergencies indicate higher number of fish per item of gear while down trend indicated lower number of fish per item of gear. Figure 17 shows wide divergencies upward or peaks. Four of these occur, one 1919, one 1923-25, one 1941-42, and one 1950-55. The first three peaks coincide with high chum catch years exceeding 150,000 fish and are thus explainable. The fourth peak 1950-1955 may represent an artifact of the regulations for licensing in force at that time. From 1949-1957 licensing districts were not in force. Apparently a gear license was good in any legal fishing area. Under these circumstances, Columbia River fishermen could fish in Willapa Bay without registering a license for the Bay so that data concerning gear licenses would not reflect the true gear potential during that period. Washington Department of Fisheries annual reports at that period indicate that they were concerned by the increasing number of Columbia River fishermen with gear (as many as 100) in Willapa Bay. Gear licenses show a downward trend during this period (See Figure 14) reflecting the regulation change which made it unnecessary for Columbia River fishermen to buy separate licenses to fish in Willapa Bay. This coupled with a peak in catch ahd produced a high peak in the fish to gear ratio but because of the reasons given above is an artifact of the regulations on licensing in effect at that time.

Another major divergence is in the severe downward trend from 1920-22. Again this apparently is not a reflection of gear-fish relationships as much as the fact that the market was bad and few licenses were obtained and few fish caught.

The wider divergencies of the ratio of fish to gear line can be explained and understood once the factors involved at the time are taken into account. The remaining portion of the graph indicates minor variations over a general trend. This trend shows an increase in the ratio of fish to gear to about 1960 when it levels off. It is surprising that with all the factors effecting catch that there is any recognizeable relationship between numbers of fish caught and number of licenses obtained. The various factors effecting catch must act together to limit the amount of gear licensed. The low fish to gear ratio of the 1960's does not reflect a significant increase in gear but is a response to the reduction in the low total number of fish taken during that period. This reduction in catch is largely due to the depression of the chum catch after the mid 1950's. It is in contrast to other areas, for instance Puget Sound, where the amout of gear has increased at a high rate since 1940 (See Figure 18). One would expect that in a declining period of a fishery the gear would not decrease until the ratio of fish to gear were so low that it was uneconomical for some fishermen. A significant number of part-time fishermen and transients from other areas may tend to buffer this reaction

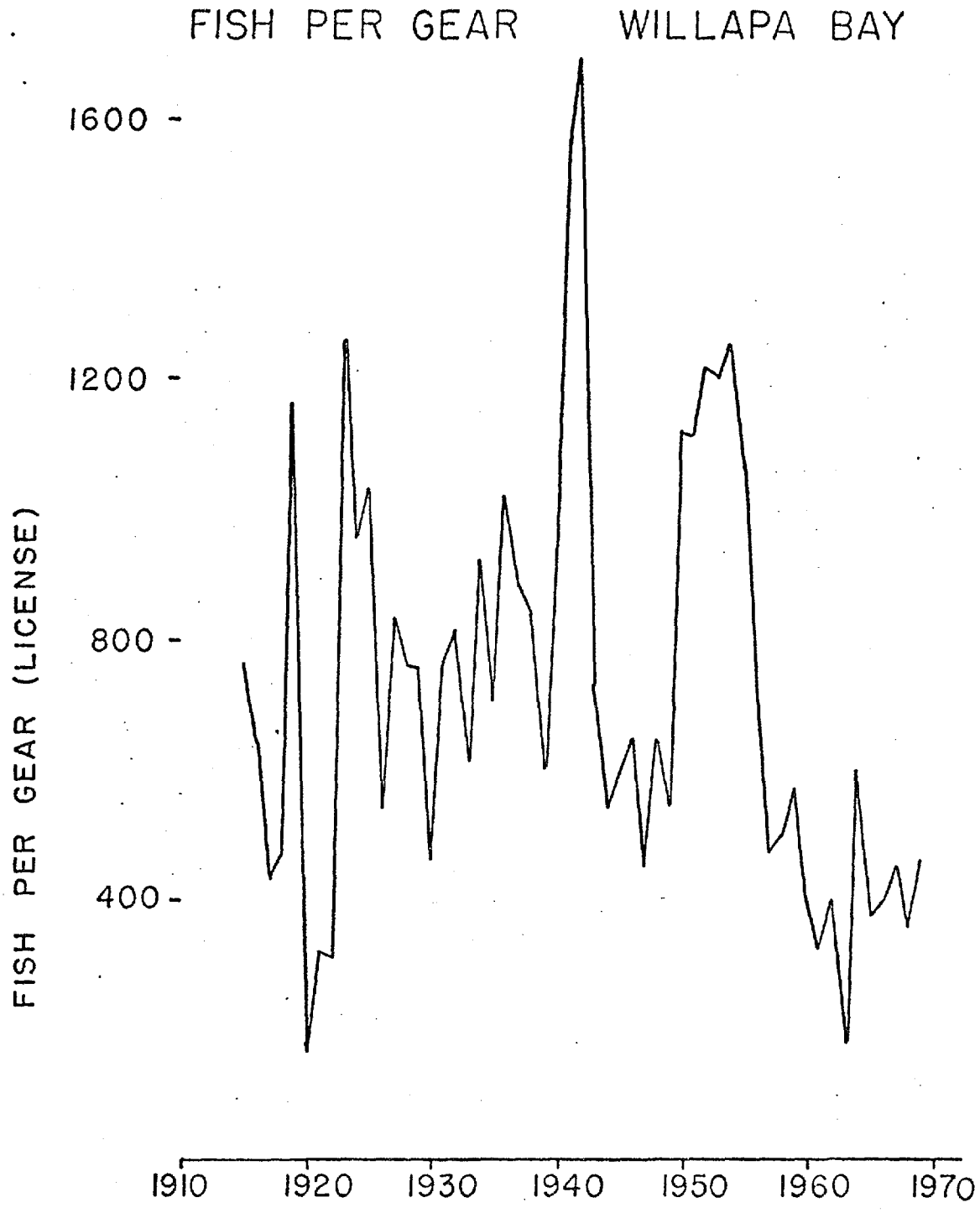

FISH PER GEAR WILLAPA BAY
1600 -
1200 -
800 -
400 -
FISH PER GEAR (LICENSE)
1910
1920
1930
1940
1950
1960
1970

FIGURE 17

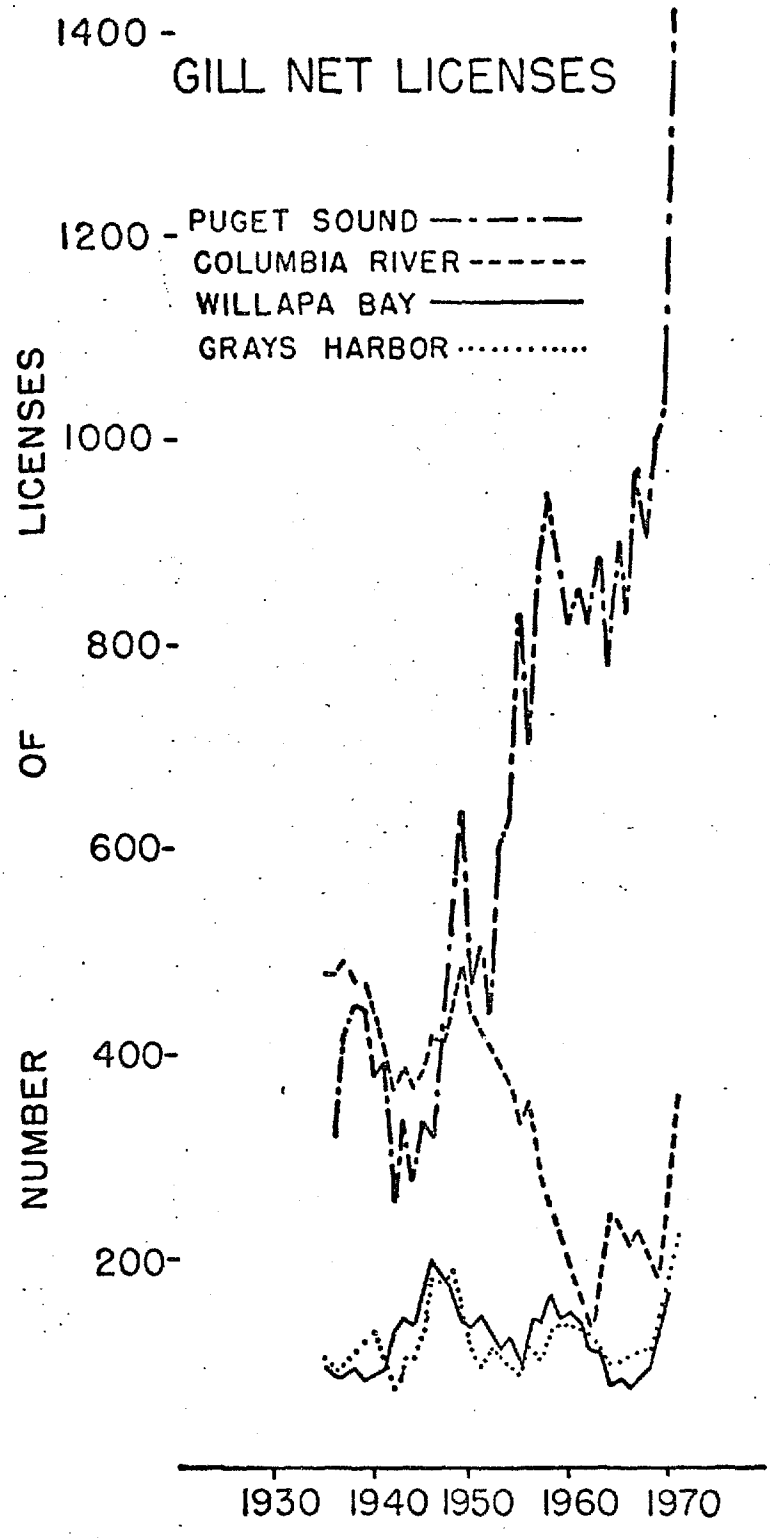

GILL NET LICENSES
PUGET SOUND
COLUMBIA RIVER
WILLAPA BAY
GRAYS HARBOR
NUMBER OF LICENSES
1400
1200
1000
800
600
400
200
1930
1940
1950
1960
1970

FIGURE 18

and that the same number of local full-time fishermen have been involved for sometime with the variations in gear licensing accounted for by others. The dual area license created by the 1971 legislature will make it very difficult to estimate potential gear in the bay however, the limited entry porposals of the 1975 legislature may tend to force part-time fishermen out or to increase their committment to the fishery. The low fish to gear ratio of the 1960's suggests that too much gear is in the fishery and that the two area licenses tends to aggrevate the situation. Since the price of fish probably cannot increase without bad market reactions, the gear should be reduced in order to allow the fishermen to produce a lower priced fish. Limited entry may tend to aid this goal.

GROWTH OF THE OCEAN SALMON FISHERY

Marketing tests conducted by the Department of Fisheries indicate that the majority of the chinook and silver salmon leaving Willapa Bay migrate north along the coast of Washington with a small number turning south. The bulk of the ocean harvest occurs along the north coast of Washington and the west coast of Vancouver Island. The Department of Fisheries estimates that an average of 50,000 silvers and 17,000 chinook from Willapa Bay were harvested each year in the ocean troll fishery between 1966 and 1970. The troll fishery has grown considerably since World War II. At that time there were less than fifty troll licenses issued for the Willapa and Grays Harbor Districts. The number in 1971 was nearly one thousand (See Figure 19). The ocean troll catch in this area has nearly quadrupled in that time (See Figure 20). The sport fishery also harvest in the ocean. An indication of the increase of this aspect of ocean harvest of chinook silver salmon is shown in Figure 20 which illustrates the ocean catch landed at Westport and La Push since World War II. The rate of increase of sport gear in the ocean fishery is apparent from angler trip records between 1955 and 1970. Figure 19 illustrates these trends and shows more than a doubling of gear each ten years. Figure 21 combines the sport and commercial troll catch to present trends and rates in the growing ocean fishery for chinook and silver.

The level of ocean harvest of salmon originating from Willapa Bay has grown rapidly since World War II particularly since 1960. At the same time plantings of chinook and silver salmon from hatcheries has increased as well as have returns to the hatcheries. (See Figure 26 and Tables 3-11). The productivity of the bay in silver and chinook salmon today may be compared to that of previous periods by totaling the ocean catch originating in the bay and it's tributaries, both troll and sport and the gill net catch in the bay. Although accurate figures cannot be assigned, it is clear that the total catch of silver and chinook originating in Willapa Bay is now as high or higher than any time in the past. This also is true for the state as a whole. The primary difference is that the harvest is being made largely in the ocean rather than in the Bay.

There is very little regulation of the ocean salmon fishery. The season essentially is the time when the salmon are near shore

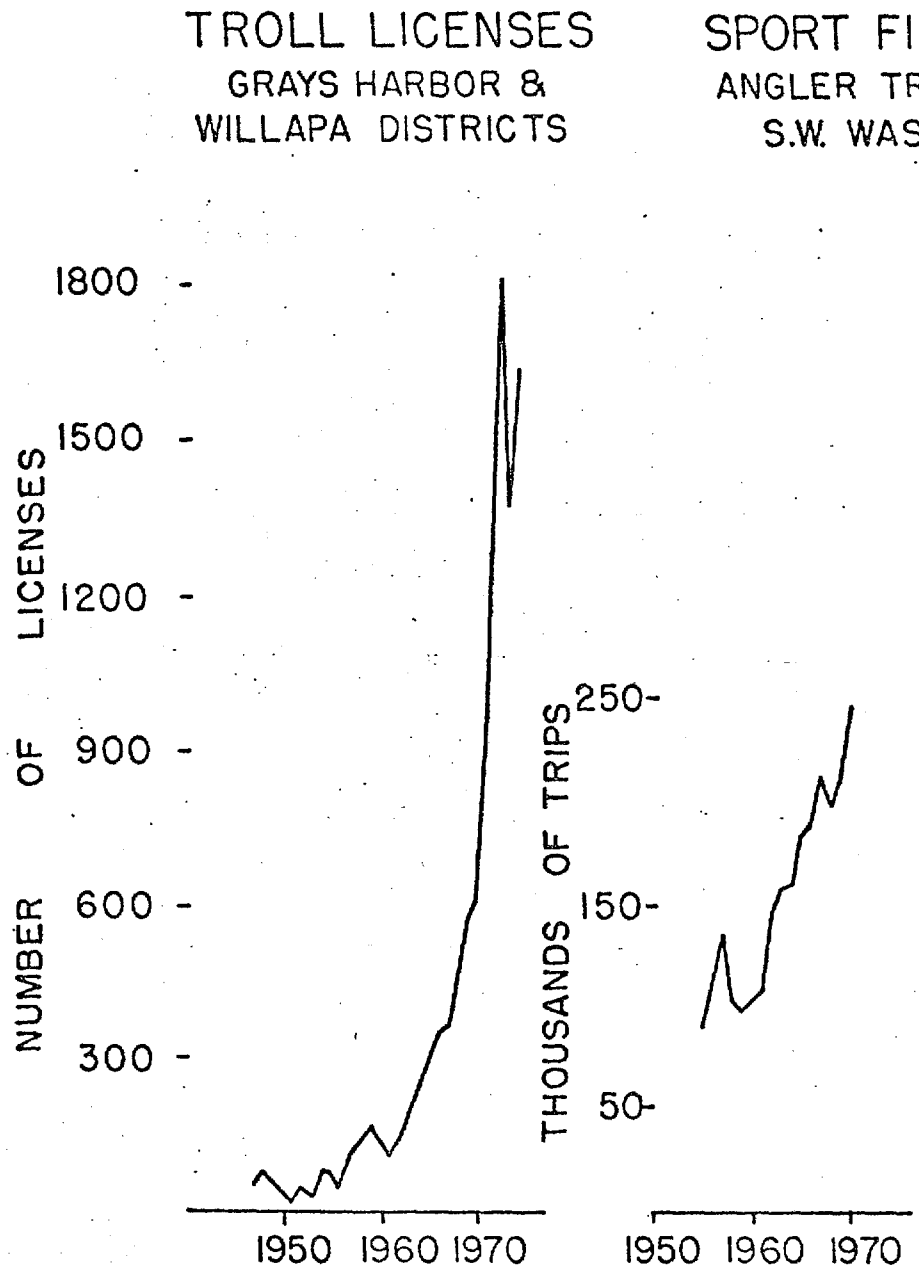

TROLL LICENSES
GRAYS HARBOR &
WILLAPA DISTRICTS
SPORT FISH
ANGLER TRIPS
S.W. WASH.
NUMBER OF LICENSES
1800
1500
1200
900
600
300
THOUSANDS OF TRIPS
250
150
50
1950 1960 1970
1950 1960 1970

FIGURE 19

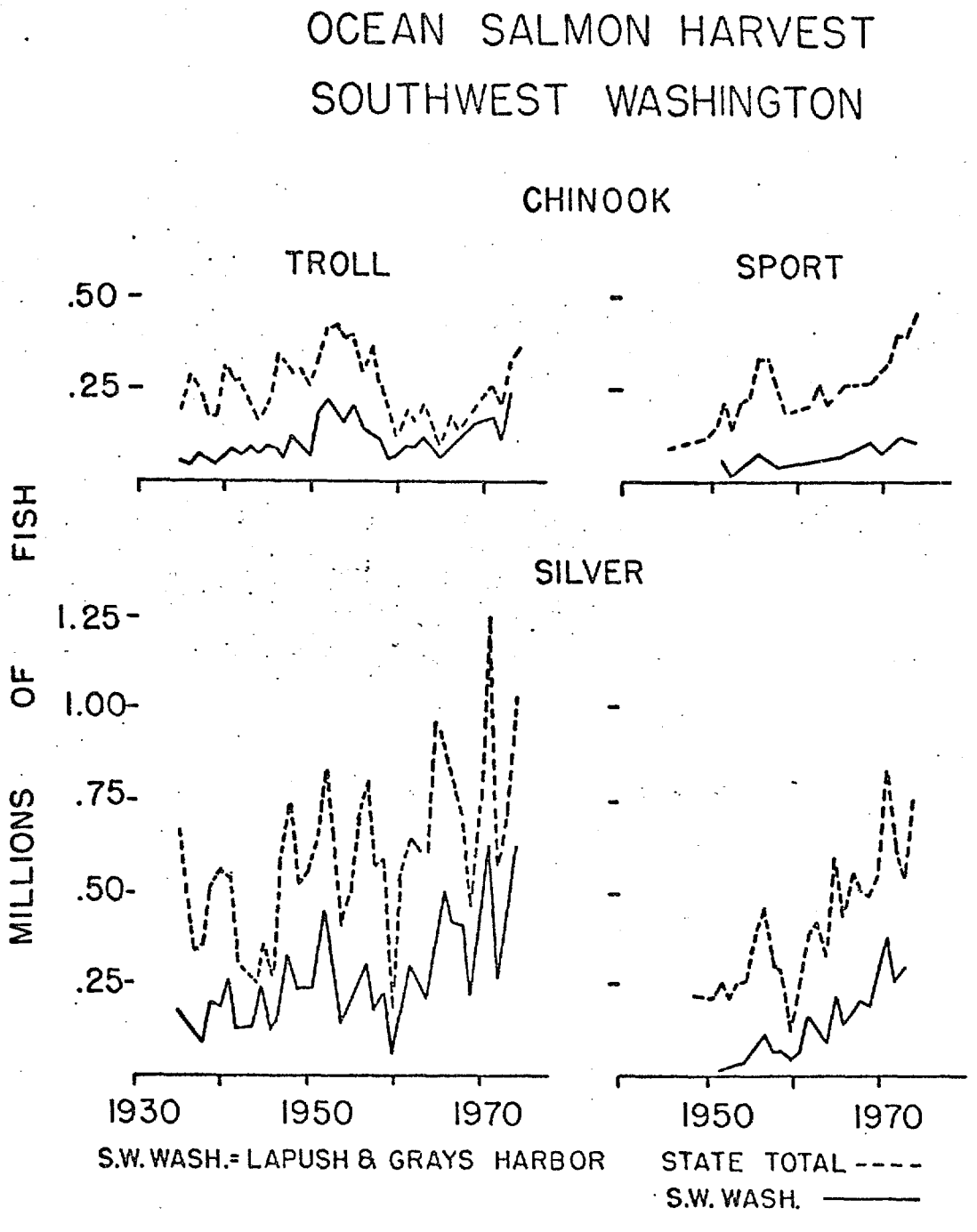

OCEAN SALMON HARVEST
SOUTHWEST WASHINGTON
CHINOOK
TROLL
SPORT
.50
.25
SILVER
1.25
1.00
.75
.50
.25
MILLIONS OF FISH
1930
1950
1970
1950
1970
S.W. WASH.= LAPUSH & GRAYS HARBOR
STATE TOTAL ----
S.W. WASH. ——

FIGURE 20

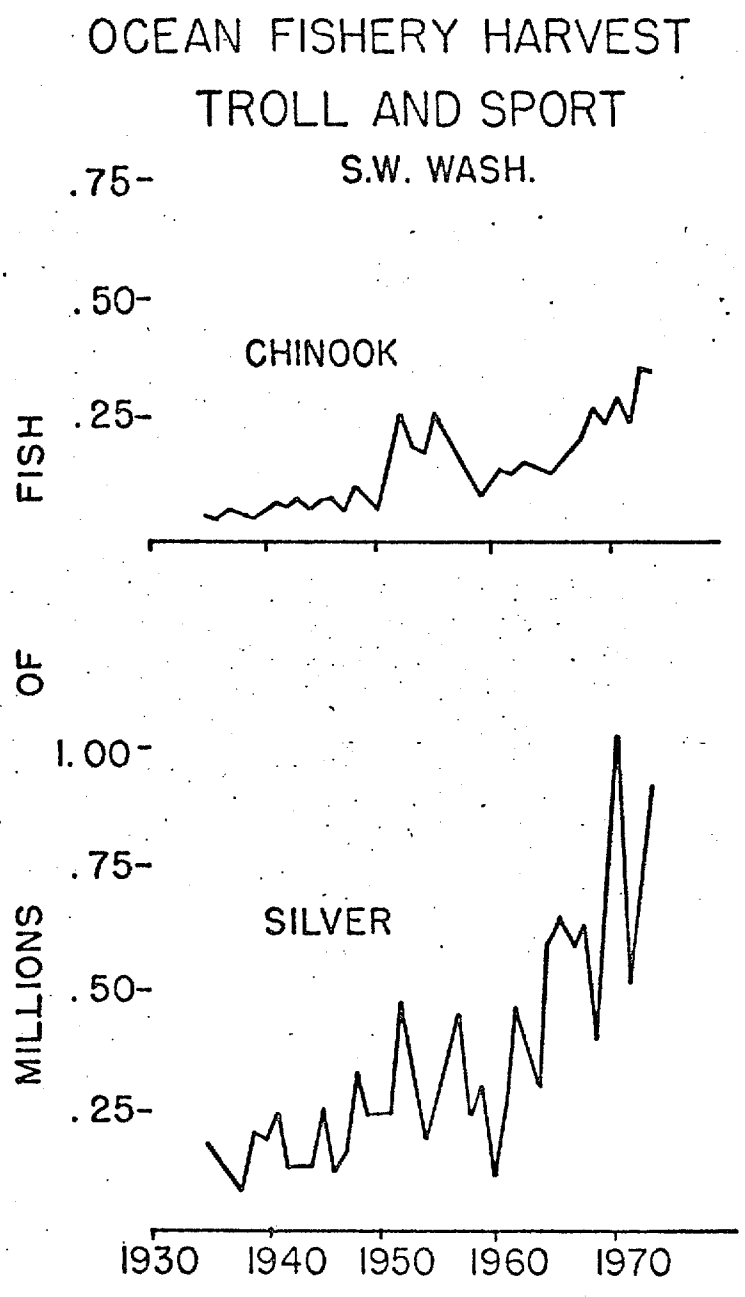

OCEAN FISHERY HARVEST
TROLL AND SPORT
S.W. WASH.
.75-
.50-
.25-
CHINOOK
FISH
OF
1.00-
.75-
.50-
.25-
SILVER
MILLIONS
1930
1940
1950
1960
1970

FIGURE 21

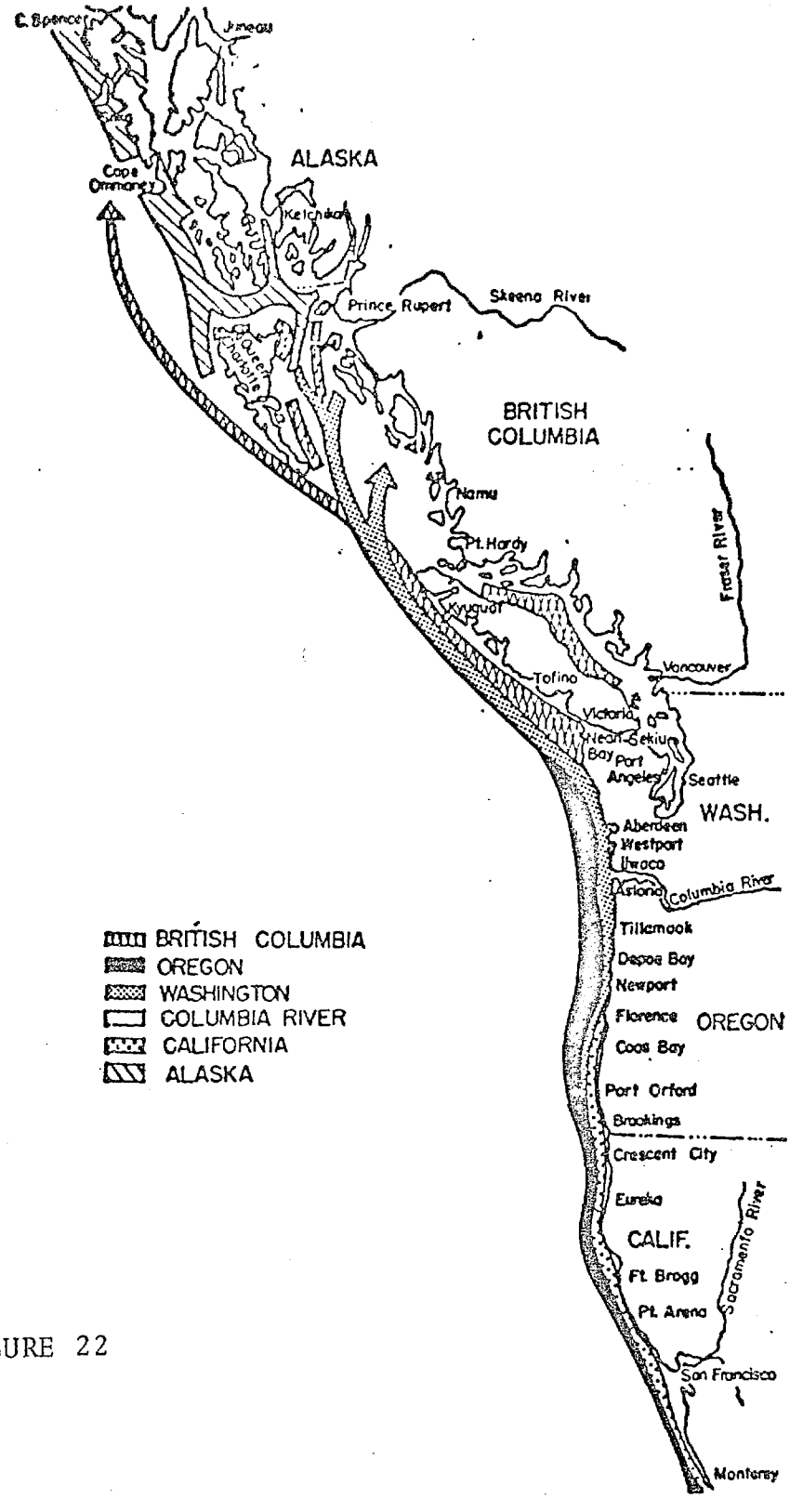


FIGURE 22

Troll Fishing Areas
(from NMFS Draft EIS Preliminary Management Plan)

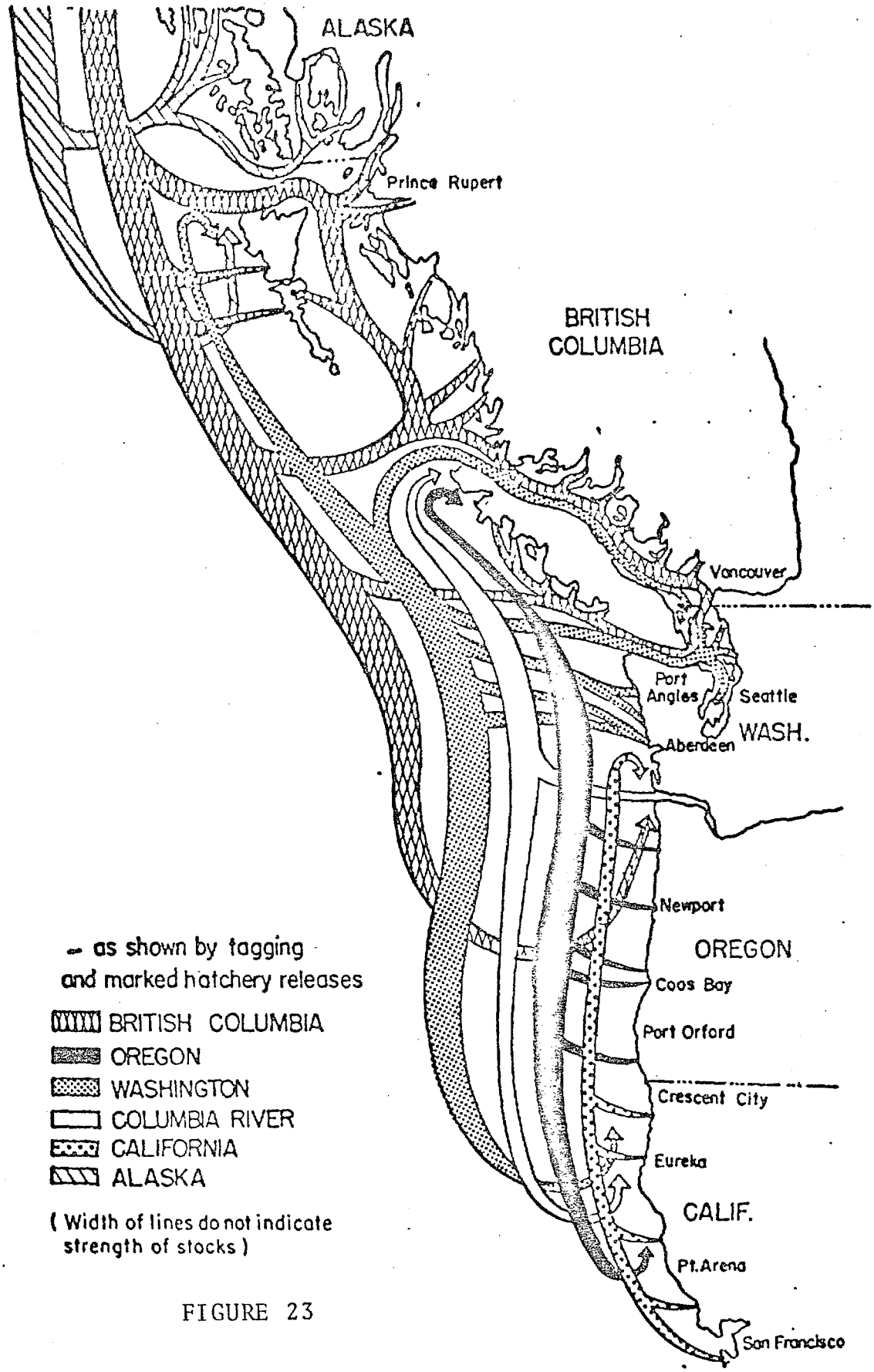


FIGURE 23

Migration Patterns of Silver Salmon
(from NMFS Draft EIS Prelinimary Management Plan)

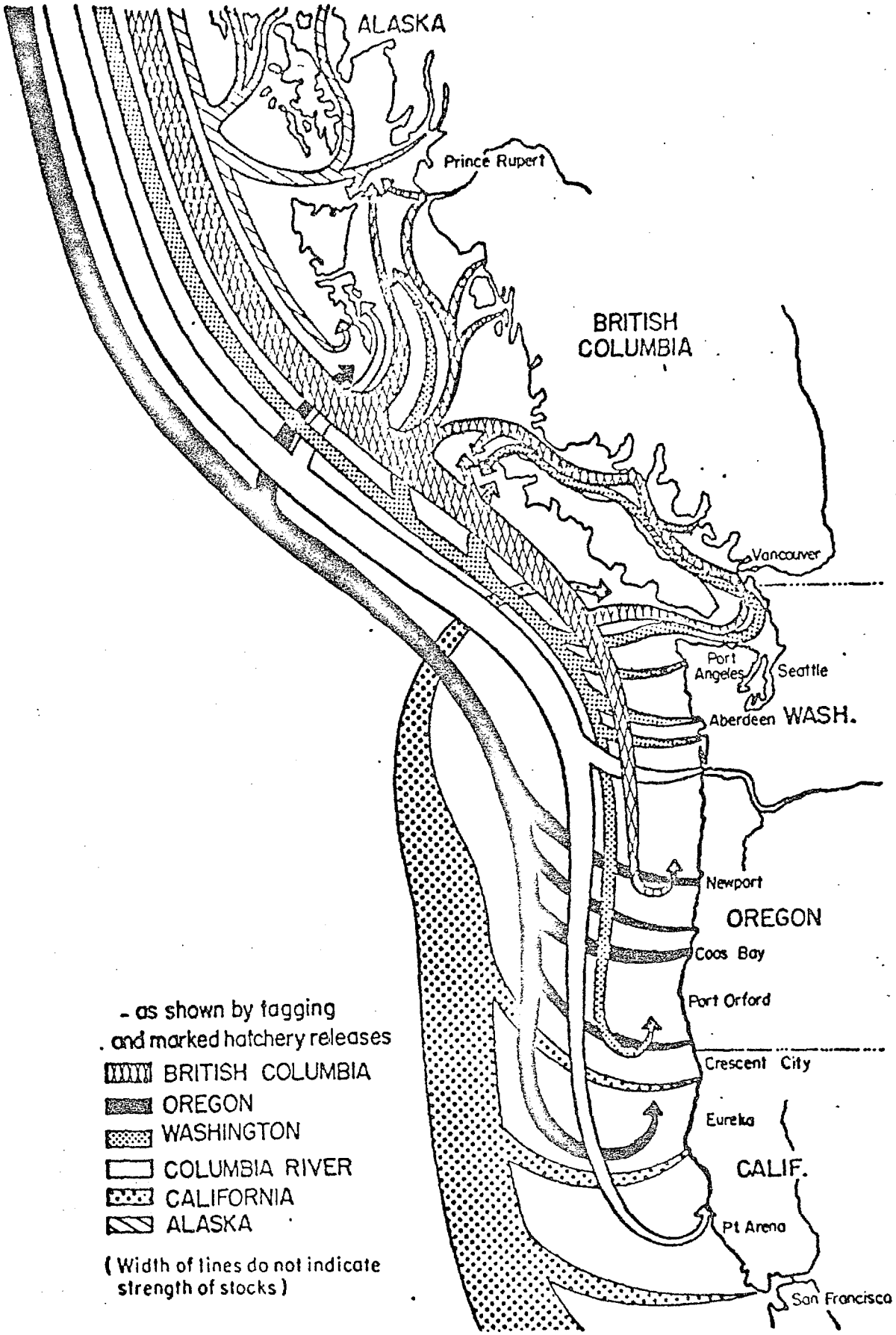


FIGURE 24

Migration Patterns of Chinook Salmon
(from NMFS Draft EIS Preliminary Management Plan)

and not yet moving into the bays and rivers. Minimum fish size and in the case of sport fishermen, maximum catch are the only limits on the fishery. In order to insure propagation of the runs, heavy season and emergency closure regulations are imposed on the gill net fishermen in the estuarine areas such as Grays Harbor, Willapa Bay and the Columbia River.

The benefits from the increased production of chinook and silver salmon accure to the ocean fishery and not to fishermen in Willapa Bay. The ability of the bay and its tributaries to supply the estimated numbers of chinook and silver taken in the ocean fishery plus that taken in the bay indicates that the productivity of the area has apparently returned to former levels.

CHUM SALMON DECLINE

Chum salmon are taken primarily by nets. They are not caught by troll or sport gear and so do not contribute to the ocean troll and sport fishery. In Washington they are harvested by gill nets and purse seines in Puget Sound, Grays Harbor, Willapa Bay and the lower Columbia River with some catch in smaller coastal streams. The chum catch has typically varied widely from year to year but after the middle 1950's declined dramatically. This decline occurred in all the fishing areas. In the Columbia River a major decline is evident in 1944 with a slight recovery through 1948 then an almost complete loss by 1960. In Willapa Bay a similar decline (See Figure 15) occurred but after 1955. The lowest catches occur in mid 1950's in Puget Sound.

Until 1960 chum salmon were the major portion of the salmon catch in Willapa Bay. They accounted for, on the average, 71% of the number of salmon caught and 64% of the poundage of salmon caught (See Figure 25). In 1958 chum salmon averaged $.17 per pound, chinook, $.33 per pound and silver $.28 per pound. The chum catch that year was sold at the dock for $118,821, the chinook for $44,334 and silver for $28,564. The price per pound to the fisherman today for all species is about three times that of 1958, however chums are accounting for a much smaller proportion of the catch. Better than average chinook seasons in six of the seven years from 1967 to 1973 has helped to balance the economic effect of the decline of chum. However these better chinook years are believed to be in part the result of harvesting some Columbia River fish which are found on occasion in Willapa Bay. With the recent apparent decline of chinook in the Columbia River system, bumper years of chinook which are in part from that system cannot be anticipated. The harvest in Willapa Bay of chinook and silver is limited to that portion of the return not taken by the ocean fishery and not required for propagation. The increase of gear in the ocean and the lack of regulation of that increase in the past indicates that the chinook and silver harvest in Willapa Bay cannot be expected to fill the gap left by the decline of the chum unless ocean harvesting is reduced.

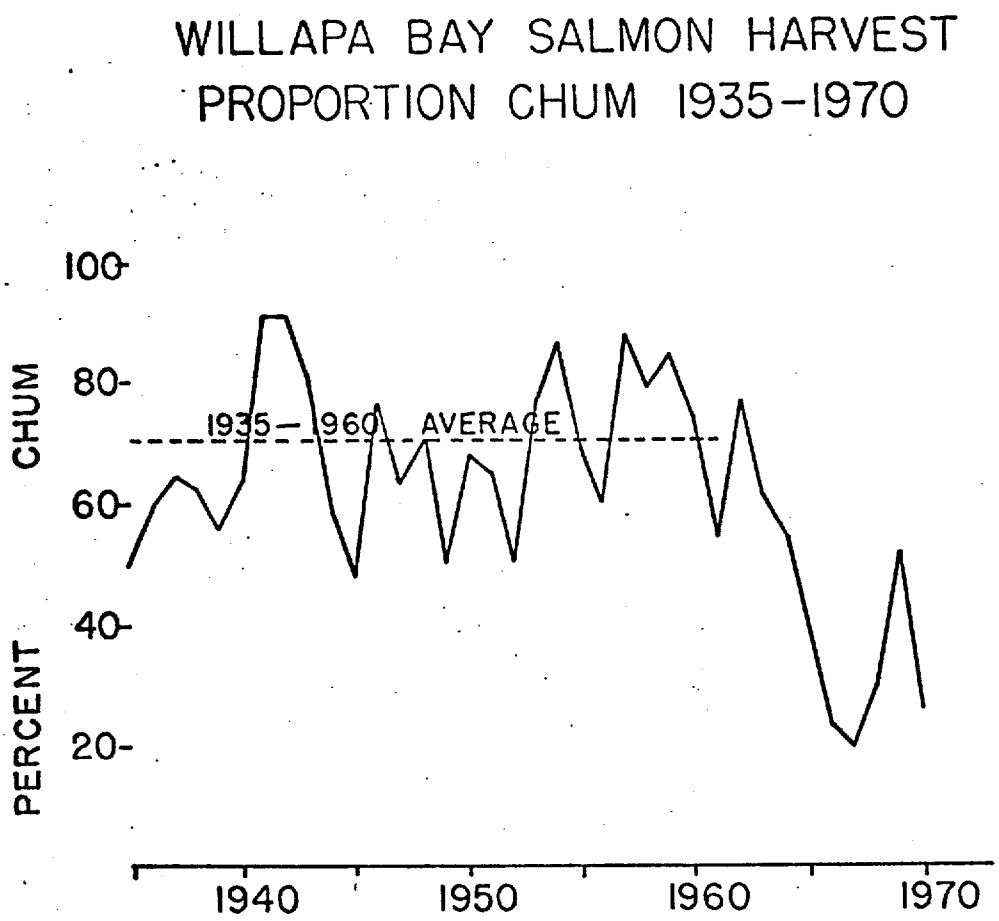

WILLAPA BAY SALMON HARVEST
PROPORTION CHUM 1935-1970
100
80
60
40
20
CHUM
PERCENT
1935-1960 AVERAGE
1940
1950
1960
1970

FIGURE 25

Although chum has a lower value per pound than chinook or silver, it has an equal ability to increase its value in processing. That is it can supply jobs in processing as well as can chinook and silver salmon. By-products from chum are of equal value to those of chinook and silver.

The decline of chum catch in Willapa Bay roughly coincides with the closure of the Nemah flats and the South end of the bay to fishing. The reduction of fishing pressure might appear as the cause for the reduced harvest. However, returns at the Nemah hatchery show the same decline (See Figure 26) even when counts at the Williams Creek rack are included. While chum returns to the hatchery have fallen off the return of silvers and chinooks had increased (See Figure 26). A significant aspect to the chum problem is in the artificial propagation policy reflected in releases from the Willapa Bay hatcheries, Figure 27 illustrates the total numbers of chinook, silver and chum juveniles released from these hatcheries. The total number had increased from 3 million in 1955 to 9 million in 1970. Chum have been released only since 1958 in this period. The proportion of chum released has reduced from a high in 1961 to 66% to 7% in 1970 (See Table 12 and Table 13). A similar trend is apparent if actual numbers of fish released is considered. Figure 27 presents this information for Willapa Bay. It appears that the silver and chinook release has been greatly expanded while chum production has been cut. It should also be noted that the high returns of chum to the Nemah hatchery in 1953, 54 and 55 were not taken for spawning (See Figure 26). No chum eggs were taken until 1957 at the Nemah hatchery. Although this may have been a missed opportunity it cannot be considered the major reason for the decline. Earlier production of chum in Willapa Bay was entirely dependent on natural propagation. Since there has been no significant increase in fishing gear and probably a reduction of fishing pressure in Willapa Bay, the decline suggests that either the natural propagation of chum has failed since sometime in the 1950's or that ocean netting has taken large numbers of chum since 1950. Ocean netting for salmon has not been allowed in Washington waters for many years.

North American and Asian chum occupy much of the North Pacific in the course of their ocean migrations. Japanese fishing areas are outlined in Figure 28. The Japanese shifted their fishery from an emphasis on a coastal and river fishery to an ocean drift net and longline fishery by 1952. The resultant Asian catch increased considerably while at the same time the North American catch dropped suddenly from an average of 14 million fish per year to 8 million fish per year (See Figure 29). There thus appears to be a possibility that a competing ocean fishery is responsible for the decline of chum in the fishing areas of Washington. However, tagging experiments indicate that Washington chum do not enter the area of the Japanese fishing although some may be taken illegally outside the limits.

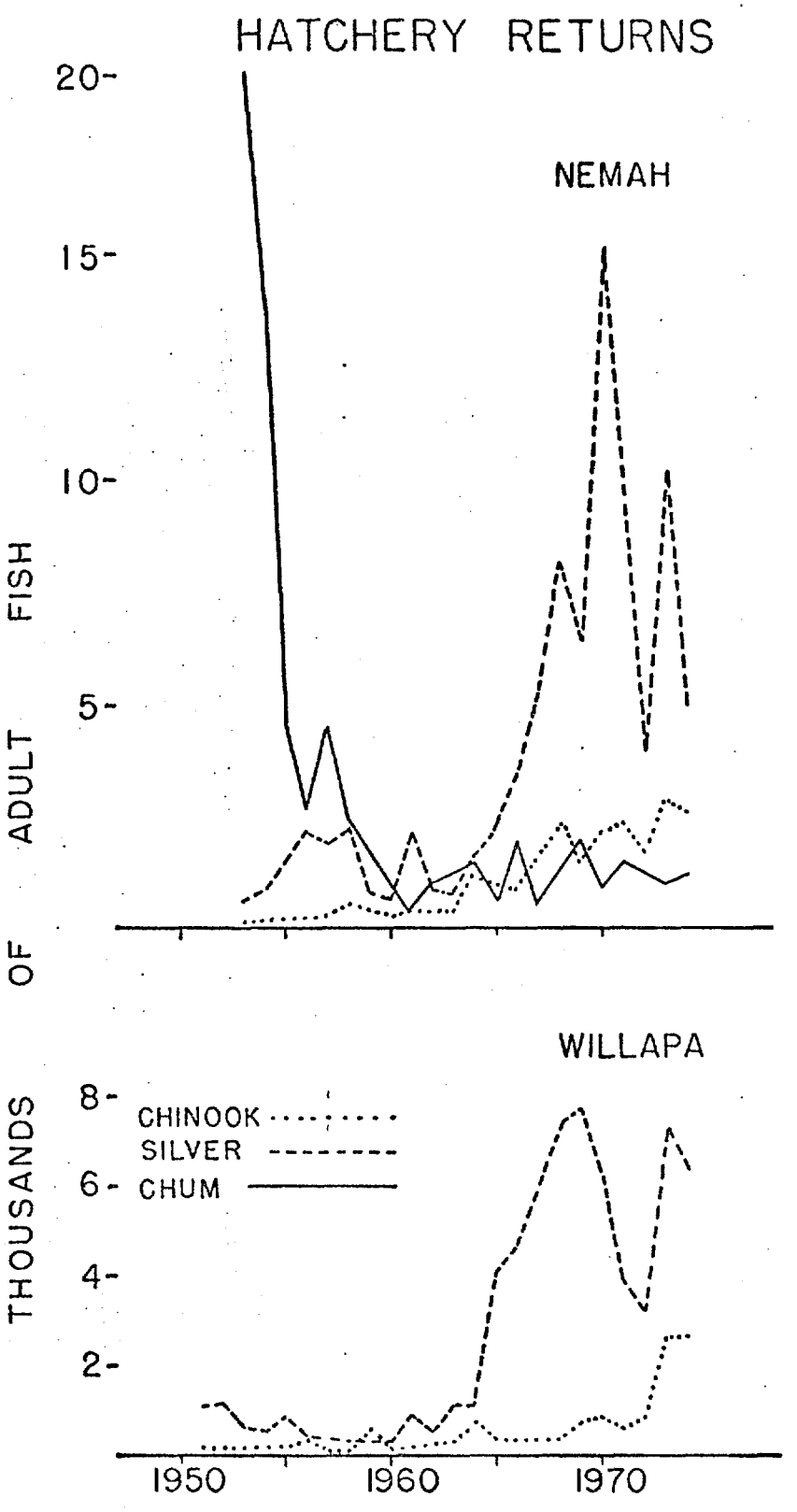

HATCHERY RETURNS
NEMAH
WILLAPA
THOUSANDS OF ADULT FISH
20-
15-
10-
5-
8-
6-
4-
2-
CHINOOK
SILVER
CHUM
1950
1960
1970

FIGURE 26

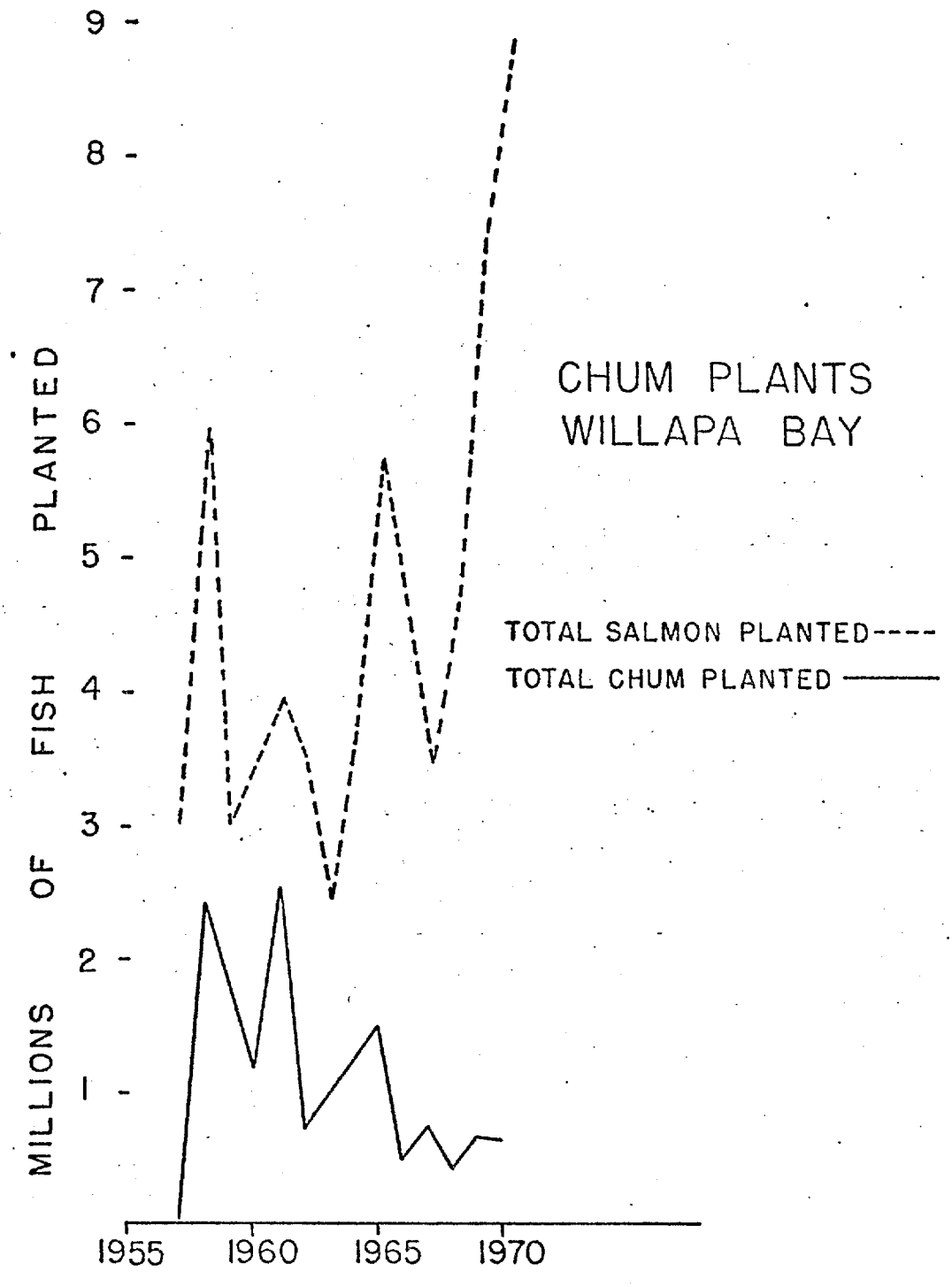
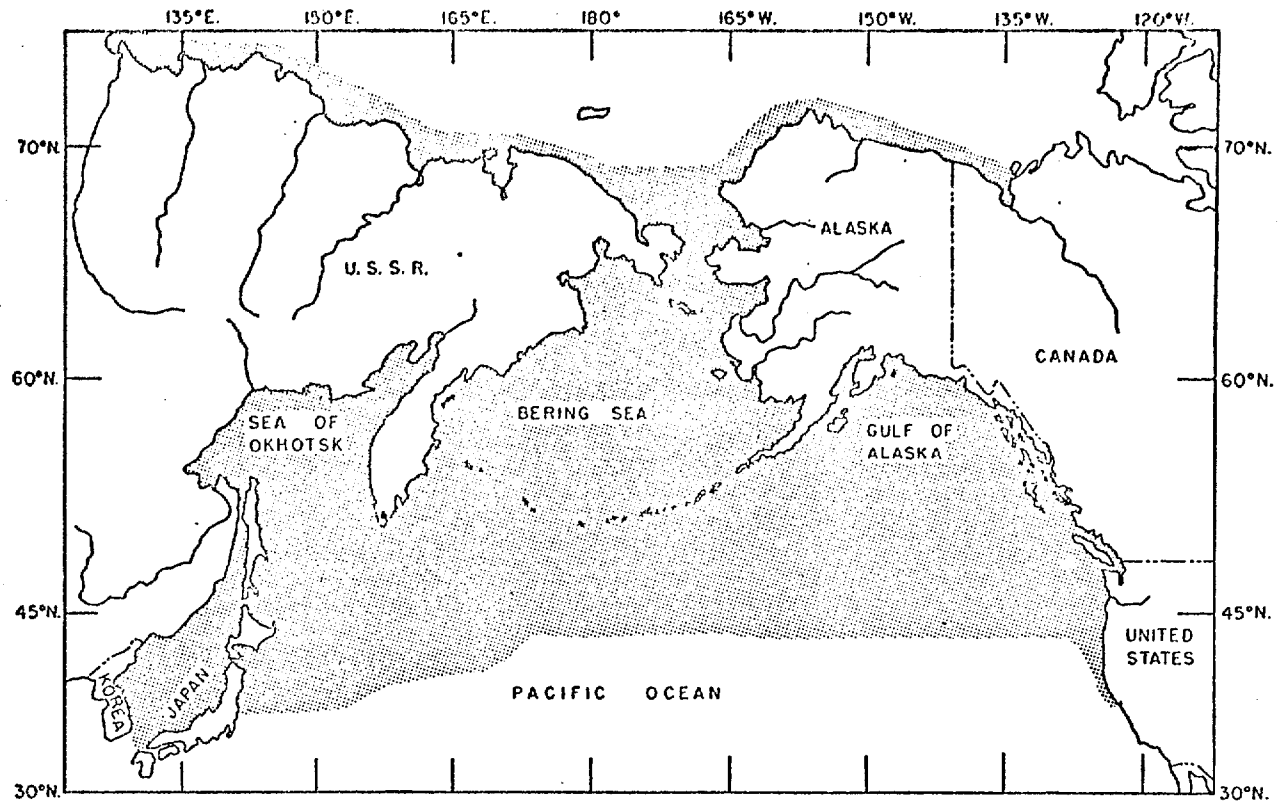
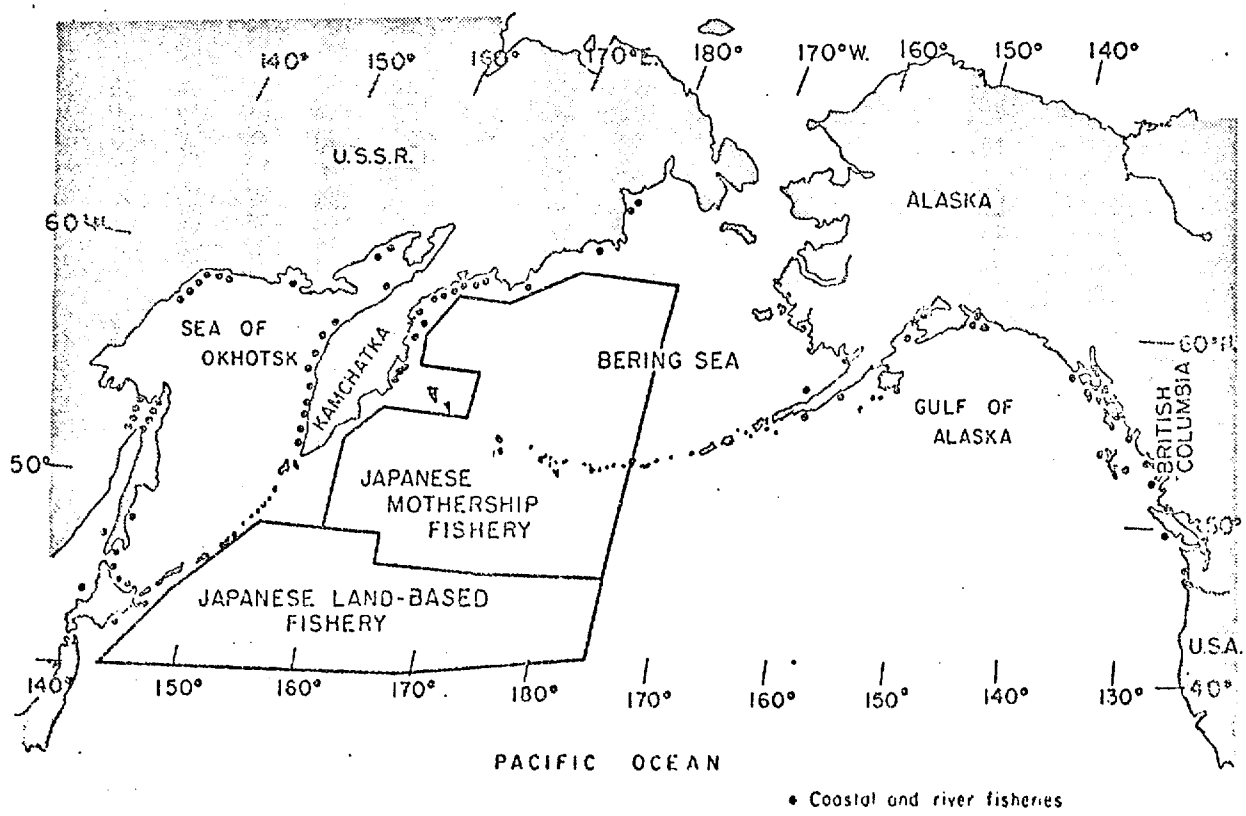

CHUM PLANTS
WILLAPA BAY
TOTAL SALMON PLANTED----
TOTAL CHUM PLANTED ——
MILLIONS OF FISH PLANTED
9
8
7
6
5
4
3
2
1
1955
1960
1965
1970

FIGURE 27



--Known coastal and ocean distribution of chum salmon.



Important fishing areas for chum salmon in Asia and North America (Kasahara, 1961; International North Pacific Fisheries Commission, 1964; Manzer et al., 1965).

FIGURE 28

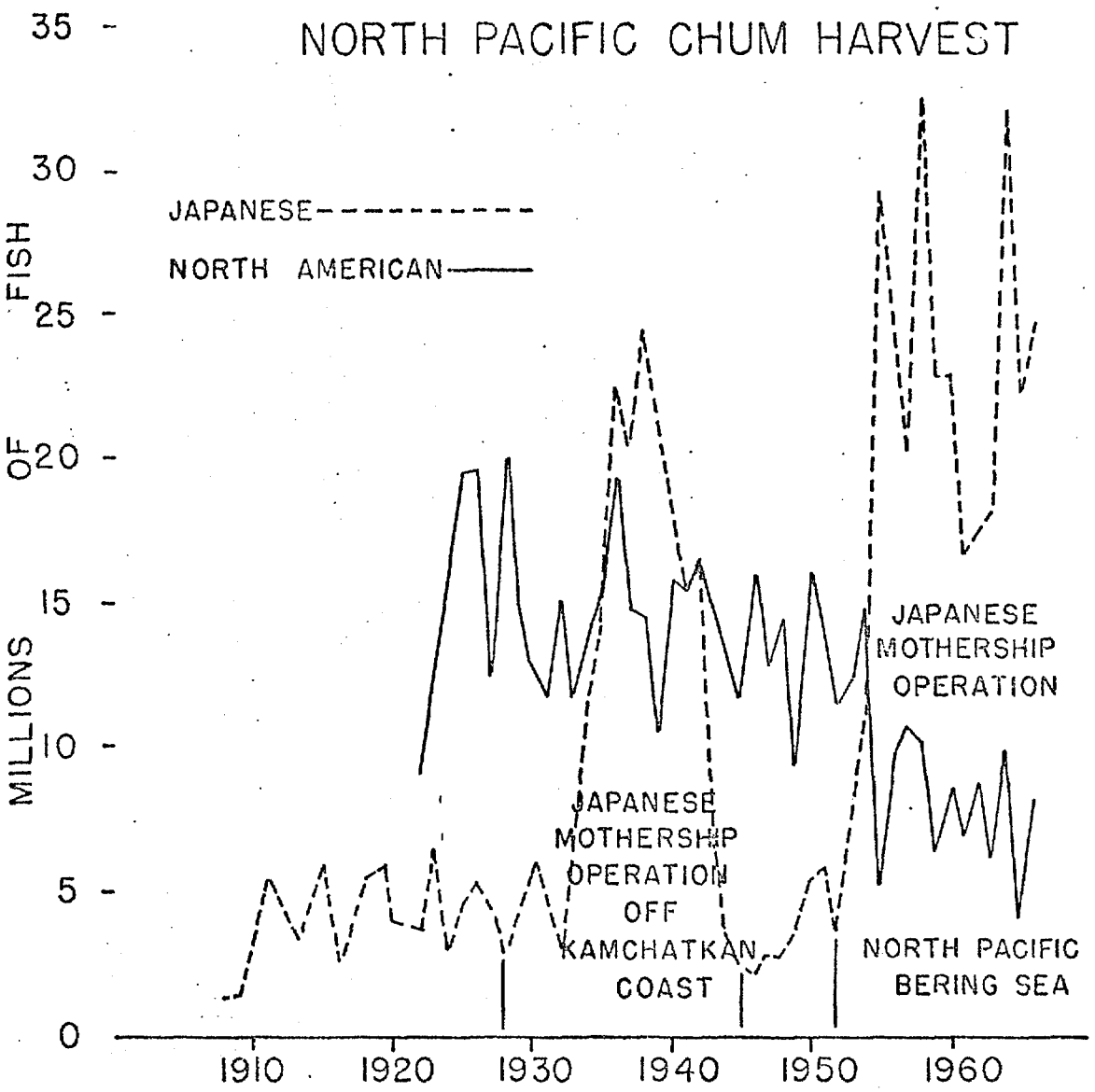

NORTH PACIFIC CHUM HARVEST
JAPANESE
NORTH AMERICAN
MILLIONS OF FISH
35
30
25
20
15
10
5
0
1910
1920
1930
1940
1950
1960
JAPANESE MOTHERSHIP OPERATION
JAPANESE MOTHERSHIP OPERATION OFF KAMCHATKAN COAST
NORTH PACIFIC BERING SEA

FIGURE 29

The Washington Department of Fisheries biologist feel that the major cause of the chum decline, as well as that of the naturally produced chinook and silver salmon, has been the wholesale destruction of the spawning and rearing habitat by logging activity.

OTHER SALMON

Pink and sockeye salmon were also harvested in Willapa Bay in the past. Steelhead were classified as salmon until 1929 when they were declared a game fish by the legislature and could no longer be sold as fresh fish but could be processed. Pink and sockeye salmon did not make up a significant part of the catch and appear only sporatically in the catch records after 1921. Steelhead made up a larger portion of the catch than did pink or sockeye but were never a major element in the fishery.

SALMON PROPAGATION

HATCHERIES

At statehood it was recognized that artificial means were necessary to propagate salmon in order to maintain the resource. The 1889-1890 legislature directed the fish commissioner to establish hatcheries and in other action expressed their concern for the loss of natural spawning grounds. The 1895 legislature appropriated funds for hatcheries in each of the four fishing districts, and the 1899 legislature approved funds for fifteen additional hatcheries. Five hatcheries have been established in the Willapa Bay drainage (See Figure 30). Many of the early hatchery sites were poorly chosen and were eventually abandoned because they were unable to procure large numbers of eggs, returns were obstructed by dams or log jams, unscreened irrigation diversions trapped downstream migrants, or pollution interferred with operation. Three of the Willapa Bay hatcheries were abandoned. North River in 1922, Willapa No. 2 in the late 1920's and Naselle in 1954. The Willapa No. 1 hatchery was built in 1899 and subsequently added to and modernized. It is in operation today. The Nemah hatchery was operating by 1953. Returns to these hatcheries are presented in Table 3. As the foot notes indicate in Table 3, a number of spawners were taken at other sites than that of the hatchery. Particularly, Trap Creek and Williams Creek. This applied primarily to the taking of chum.

Early hatchery programs involved the taking of large numbers of eggs with very little rearing of the swim-up fish. The records of egg taking at Willapa Bay hatcheries between 1900 and 1934 reflects this program, Table 4-8. Later hatchery programs involved taking smaller numbers of eggs and extended rearing of the fry. Egg taking at Willapa Bay hatcheries from 1948 to 1970, Tables 4-6, follow this program and ponds were constructed at the Willapa and Nemah hatcheries for extended rearing of silver (about 1 year) and the shorter term rearing of chinook. Although considerable numbers of chum eggs were taken during the early hatchery program in Willapa Bay, chum were not incubated until the late 1950's under the later program. The available records indicate that chum eggs were not taken for nearly 20 years proceeding the late 1950's.

Department of Fisheries personel feel that hatchery operations before the 1950's did little to enhance the fishery and may have been harmful in some instances. The lack of disease control methods and an adequate hatchery food limited the success of the hatcheries. The early release of fish reduced their survival potential. Overloading of streams with young fish resulted in a poor quality seaward migrant because of the limitations of natural food and may have adversely effected natural populations in these streams.

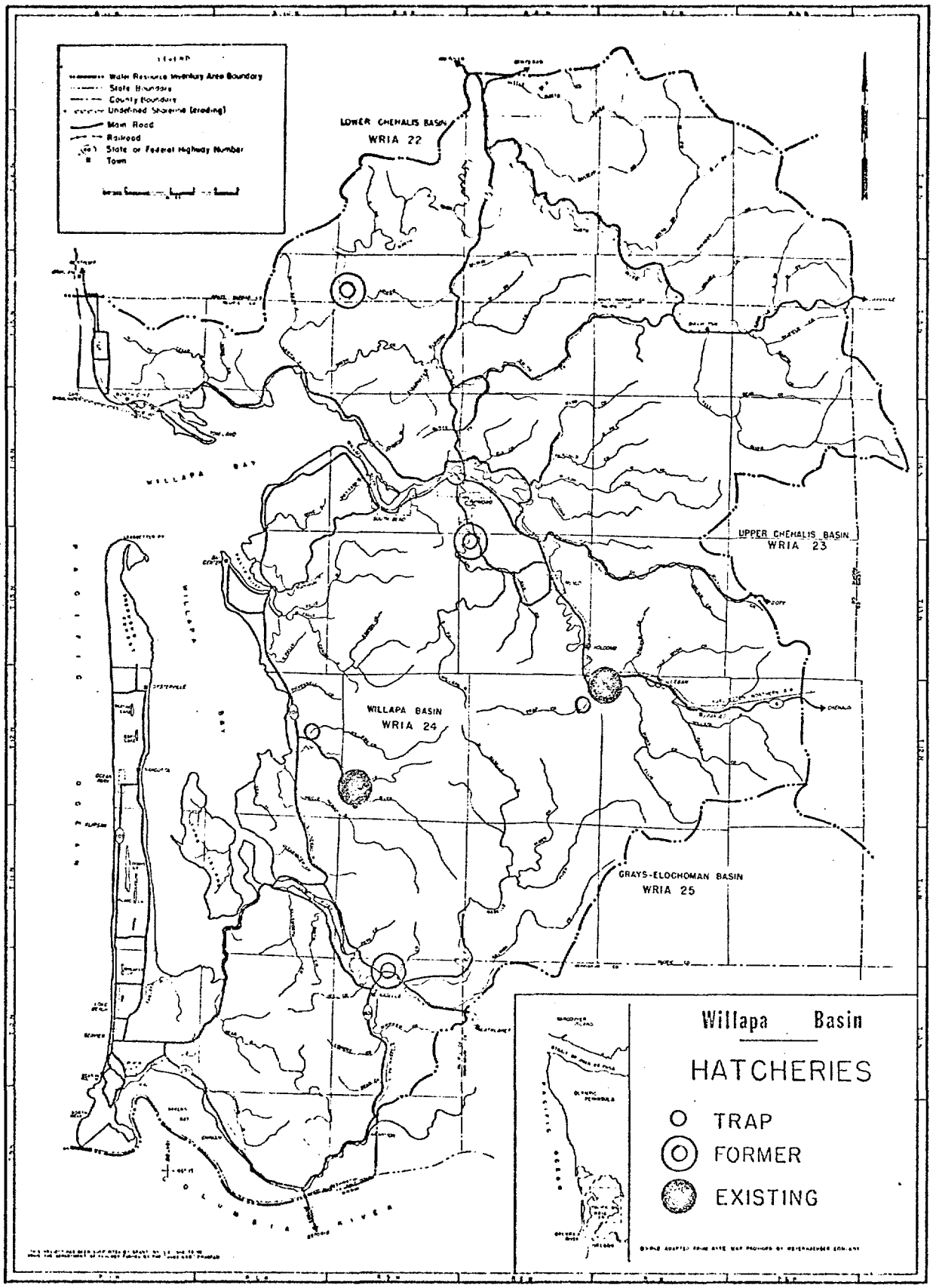

LOWER CHEHALIS BASIN
WRIA 22
UPPER CHEHALIS BASIN
WRIA 23
WILLAPA BASIN
WRIA 24
GRAYS-ELOCHOMAN BASIN
WRIA 25
Willapa Basin
HATCHERIES
TRAP
FORMER
EXISTING

FIGURE 30

TABLE 3 - ADULT ESCAPEMENT TO HATCHERY RACKS

	CHINOOK SALMON		SILVER SALMON		CHUM SALMON	
YEAR	NEMAH	WILLAPA	NEMAH	WILLAPA	NEMAH	WILLAPA
1938	-----	296	-----	1,690	-----	-----
1939	-----	125	-----	1,118	-----	-----
1940	-----	392	------	925	-----	-----
1941	-----	474	-----	587	-----	-----
1942	-----	145	-----	360	-----	-----
1943	-----	75	-----	985	-----	-----
1944	-----	20	-----	2,208	-----	-----
1945	-----	106	-----	1,415	-----	-----
1946	-----	104	-----	362	-----	-----
1947	-----	31	-----	708	-----	-----
1948	-----	52	-----	390	-----	-----
1949	-----	147	-----	451	-----	-----
1950	-----	174	-----	703	-----	-----
1951	-----	215	-----	1,031	-----	-----
1952	-----	182	-----	1,282	-----	-----
1953	10	240	674	766	20,382	-----
1954	50	241	831	616	13,982	-----
1955	165	369	1,634	921	4,609	-----
1956	175	400	2,068	411	2,714	-----
1957	192	133	1,872	386	4,485	-----
1958	644	127	2,180	339	2,440	-----
1959	504	619[1]	805	479	1,860	-----
1960	173	239[2]	678[4]	300	4,478[8]	213[9]
1961	373	244[3]	2,212[5]	988	1,634[10]	168
1962	400	358	840[6]	572	994	-----
1963	403	399	733[7]	1,117	1,253	-----
1964	1,298	742	1,607	1,100	1,373	-----
1965	908	339	2,202	4,074	609	-----
1966	796	419	3,379	4,739	2,082	-----
1967	1,416	316	5,310	5,944	404	-----
1968	2,303	353	8,020	7,484	1,030	-----
1969	1,398	745	6,310	7,719	1,994	-----
1970	2,034	817	15,065	6,415	805	-----
1971	2,302	567	9,916	3,875	1,415	-----
1972	1,719	825	3,975	3,226	1,229	-----
1973	2,842	2,645	10,137	7,398	991	-----
1974	2,500	2,500	4,954	6,306	1,099	-----

NOTES:

1/ 376 of this number were gaffed
2/ Includes 26 fish from Trap Creek
3/ Includes 22 fish from Trap Creek
4/ Includes 97 fish from Williams Creek
5/ Includes 671 fish from Black Lake Fish Farm; 23 from Williams Cr.
6/ Includes 137 fish from Black Lake
7/ Figure represents only those fish that were spawned
8/ Includes 3,261 fish from Williams Creek
9/ Includes 71 fish from Johnson's Slough
10/ Includes 1,215 fish from Williams Creek

(Composite from WSDF Annual Reports)

TABLE 4

EGG TAKE – WILLAPA HATCHERY

YEAR	CHINOOK	SILVER	CHUM	TOTAL
1948	11,299	189,953		201,252
1949	117,182	437,575		554,757
1950				
1951	181,773	48,131		229,904
1952	263,483	503,841		767,324
1953	401,338	381,922		783,260
1954	307,247	161,571		468,818
1955				
1956				
1957	302,920	753,400		1,074,320
1958	299,235	407,565	2,000	708,800
1958	1,090,794 1/	600,651	2,100 2/	1,693,645
1960	437,635 1/	287,601	165,580 2/	890,816
1961	239,646	694,481	157,509	1,091,636
1962	473,749	582,026		1,055,775
1963	405,495	911,872		1,317,367
1964	1,862,080	1,235,333		3,097,413
1965	803,614	1,338,503		2,142,117
1966		2,986,874		2,986,874
1967	1,344,022 3/	1,755,956		3,099,978
1968	2,408,055 4/	2,098,911		4,506,967
1969	3,027,102 4/	2,366,177		5,393,279
1970	575,774	3,330,023		3,905,797
1971				
1972				
1973	2,513,655	3,285,516		
1974				

TABLE 5

EGG TAKE – NASELLE HATCHERY

1948		461,360		461,360
1949		211,170		211,170
1950				
1951		168,130		168,130
1952	21,696	351,000		372,696
1953	6,216			6,216

TABLE 6

EGG TAKE – NEMAH HATCHERY

1953	18,119	68,532		86,651
1954	122,449	193,026		315,475
1955				
1956				
1957	151,190	619,740	3,013,450	3,784,380
1958	618,211	821,896	1,984,520	3,424,627
1959	804,967	412,721	1,448,253 5/	2,665,941
1960	236,644 6/	519,726 7/	2,853,552 8/	3,609,922
1961	522,800 6/	1,716,300 9/	427,300 8/	2,666,400
1962	562,400	690,780 10/	1,042,700	2,295,880
1963	502,900	558,820 10/	1,336,615	2,398,335
1964	1,241,097	1,038,690	1,863,350	4,143,137
1965	1,365,520	752,095	607,200	2,724,815
1966	468,760	1,355,580	891,400	2,715,740
1967	1,425,400	1,176,300	441,780	3,043,480
1968	3,149,080	2,027,500	1,007,600	6,184,180
1969	2,073,694	2,349,042	1,388,195	5,810,931
1970	1,096,560	2,571,570	978,100	5,646,230
1971				
1972				
1973	1,809,105	1,497,440		1,473,680
1974				

NOTES:
1/ 31,129 Chinook from Trap Creek
2/ All Chum from Trap Creek
3/ 1,643,800 Chinook from Deschutes River
4/ 1,616,370 Chinook from Deschutes River
5/ 2,121,635 Chum from Williams Creek
6/ 244,750 Chum from Williams Creek
7/ 958,130 Silver fish farm Black Lake
8/ 224,000 Chinook Deschutes
9/ 152,395 Silver -Black Lake
10/ 177,260 Silver-Black Lake

TABLE 7 TOTAL EGG TAKE – WILLAPA HATCHERIES

YEAR	WILLAPA	NASELLE	NEMAH	TOTAL
1948	201,252	461,360		662,612
1949	554,757	211,170		765,927
1950	714,886	564,000		1,278,886
1951	229,904	168,130		398,034
1952	767,324	372,696		1,140,020
1953	783,260	6,216	86,651	876,127
1954	468,818		315,475	784,293
1955				
1956				
1957	1,074,320		3,784,380	4,858,700
1958	708,800		3,424,627	4,133,427
1959	1,693,645		2,665,941	4,359,586
1960	890,816		3,609,922	4,500,738
1961	1,091,636		2,666,400	3,758,036
1962	1,055,775		2,295,880	3,351,655
1963	1,317,367		2,398,335	3,715,702
1964	3,097,413		4,143,137	7,240,550
1965	2,142,117		2,724,815	4,866,932
1966	2,986,874		2,715,740	5,702,614
1967	3,099,978		3,043,480	6,143,458
1968	4,506,967		6,184,180	10,691,147
1969	5,393,279		5,810,931	11,204,210
1970	3,905,797		5,646,230	9,552,027

TABLE 8

YEARLY COMPARATIVE TABLE OF EGG TAKE IN WILLAPA HARBOR DISTRICT SALMON HATCHERIES

YEAR	CHINOOK	CHUM	SILVER	STEELHEAD	TOTALS
1900	---------	----------	---------	---------	726,000
1902	---------	----------	---------	---------	4,958,910
1903	---------	----------	---------	---------	1,605,300
1904	700,000	----------	2,000,000	320,000	3,020,000
1905	588,500	----------	2,400,000	189,500	3,178,000
1906	437,400	----------	2,500,000	585,000	3,522,400
1907	678,600	----------	654,500	148,500	1,481,600
1908	322,200	----------	504,000	399,000	1,225,200
1909	455,200	----------	64,000	---------	519,200
1910	773,000	----------	2,731,000	400,000	3,904,000
1911	788,000	----------	3,457,500	405,100	4,650,600
1912	768,000	----------	1,540,000	510,000	2,818,000
1913	1,345,500	----------	2,004,000	292,000	3,641,500
1914	437,700	----------	953,500	87,500	1,478,700
1915	1,759,775	----------	807,600	11,250	2,578,625
1916	1,759,775	----------	807,600	11,250	2,578,625
1917	2,237,800	----------	1,151,250	813,800	4,202,850
1918	1,608,200	336,350	2,219,750	285,500	4,449,800
1919	7,389,250	1,016,000	3,002,700	1,531,400	12,939,350
1920	323,000	5,348,500	5,589,850	2,224,750	13,486,100
1921	6,587,200	---------	6,756,500	2,482,600	15,826,300
1922	3,217,000	---------	9,139,000	2,299,000	14,655,000
1923	7,572,900	---------	8,382,000	2,222,000	18,176,900
1924	2,903,000	---------	6,688,000	1,321,000	10,912,000
1925	6,498,600	---------	7,163,500	1,391,000	15,053,100
1926	10,801,100	227,500	3,286,500	762,500	15,077,600
1927	6,997,000	184,500	3,370,000	1,201,500	11,753,000
1928	3,636,200	5,852,000	4,416,000	846,500	14,750,700
1929	7,258,800	4,760,700	3,814,000	638,000	16,471,500
1930	5,880,700	2,748,500	5,450,500	982,000	15,061,700
1931	11,478,500	9,722,500	3,960,750	510,000	26,671,750
1932	16,282,500	5,147,500	1,452,000	520,000	23,402,000
1933	12,089,000	1,228,500	1,842,000	470,000	15,629,500
1934	7,828,000	3,452,500	2,322,000	670,000	14,272,500

TABLE 9

FISH PLANTS from WILLAPA BAY HATCHERIES

YEAR	Willapa River	North River	Williams Cr.	Palix River	Nemah River	Naselle Riv.	Bear River	Black Lake	Johnson Slough	Grays Harbor		Chinook R.	Niawiakum River
1948	X			X	X	X	X			X			
1949	X			X	X	X	X			X			
1950	X			X	X	X	X			X			
1951	X			X	X	X	X			X			
1952													
1953													
1954	X	X		X	X	X							
1955													
1956													
1957	X	X		X	X	X	X						
1958	X	X		X	X	X	X						
1959	X	X		X	X	X	X						
1960	X	X		X	X	X							
1961	X				X			X	X				
1962	X				X	X	X	X	X				
1963	X	X	X		X	X		X					
1964	X	X			X			X	X				
1965		X		X	X	X		X	X				
1966	X	X	X	X	X	X	X		X				
1967	X				X								
1968	X	X				X	X			X		X	
1969	X	X		X	X	X	X			X			X
1970	X	X	X		X	X	X						X

TABLE 10

YEARLY COMPARATIVE TABLE OF FRY PLANTED FROM THE STATE HATCHERIES

DISTRICT AND YEAR	Chinook	Dog	Silver	Steelhead	Totals
GRAYS HARBOR DISTRICT–					
1913	139,000	497,300	2,600,000	701,118	3,937,418
1914	93,250	1,230,000	4,136,840	561,900	6,021,990
1915	674,760	3,404,465	4,324,207	801,806	9,205,298
1916	674,760	3,404,465	4,324,208	801,867	9,205,300
1917	2,978,288	17,725,949	12,275,990	967,975	33,948,202
1918	279,200	4,763,000	6,017,655	1,847,400	12,907,255
1919	318,800	5,610,000	10,593,100	2,245,700	18,767,600
1920	1,928,839	27,694,449	13,134,755	1,007,500	43,765,543
1921	4,376,450	---------	12,706,213	1,296,005	18,378,668
1922	1,599,530	---------	17,218,000	799,870	19,617,400
1923	826,420	5,601,420	17,822,610	504,172	24,754,622
1924	313,519	3,640,000	9,720,231	450,640	14,124,390
1925	172,279	9,773,459	16,023,401	306,300	26,275,439
1926	458,700	1,131,000	19,209,590	626,550	21,425,840
1927	314,000	1,340,000	19,501,790	530,950	21,686,740
1928	173,425	2,052,700	9,185,148	554,890	11,966,163
WILLAPA HARBOR DISTRICT–					
1913	3,247,345	---------	1,636,765	248,555	5,132,665
1914	302,461	1,581,750	291,460	105,440	2,281,111
1915	2,374,145	590,860	769,290	--------	3,734,295
1916	2,374,145	590,860	769,291	--------	3,734,396
1917	5,411,725	2,359,805	1,809,901	771,600	10,353,031
1918	1,460,206	318,100	372,500	197,000	2,347,866
1919	5.458,500	936,400	2.184,900	931,100	9,510,900
1920	294,604	5,613,783	4,885,268	1,666,500	12,460,155
1921	6,023,500	80,585	3,208,420	1,240,900	10,563,405
1922	2,536,780	---------	10,865,300	1,909,000	15,311,080
1923	5,072,605	---------	4,705,340	979,885	10,757,830
1924	3,784,325	---------	3,591,000	631,790	8,007,115
1925	6,338,790	---------	8,270,645	1,085,342	15,094,777
1926	8,989,450	205,265	2,820,165	530,535	12,545,415
1927	5,214, 95	167,395	7,393,235	206,410	12,981,735
1928	2,559,306	5,344,940	1,970,445	596,825	10,471,516

(Adapted from WSDF Annual Report)

TABLE 11

TOTAL PLANT OF SALMON BY SPECIES AND AGE GROUP

1950 -- 1970

WILLAPA HARBOR, GRAYS HARBOR, AND COASTAL DISTRICTS

CALENDAR YEAR	FALL CHINOOK		SILVER		CHUM		TOTAL
	Fry	Reared	Fry	Reared	Fry	Reared	All Species
1950	-------	1,545,151	-------	889,645	-------	-------	2,434,796
1951	-------	3,467,262	156,636	806,325	-------	-------	4,430,223
1952	-------	3,889,507	17,864	670,432	-------	-------	4,814,260
1953	-------	4,369,748	-------	1,610,299	-------	-------	6,369,407
1954	-------	1,616,713	-------	1,297,384	-------	-------	2,914,097
1955	-------	3,065,192	-------	1,491,612	-------	-------	4,557,804
1956	-------	2,541,867	-------	1,883,846	-------	-------	4,425,713
1957	-------	4,374,081	-------	1,571,225	-------	-------	5,945,306
1958	-------	2,942,143	-------	3,593,255	-------	1,969,383	8,504,781
1959	-------	3,195,958	-------	1,213,153	1,950	1,815,430	6,226,491
1960	-------	4,240,849	-------	1,557,973	2,000	2,106,192	7,907,014
1961	-------	717,945	-------	1,739,277	-------	3,653,316	6,110,538
1962	-------	668,160	972,050	3,222,305	63,000	754,610	5,680,125
1963	-------	1,206,692	-------	1,035,837	-------	1,634,995	3,877,524
1964	-------	2,056,999	-------	2,508,608	-------	1,496,580	6,062,187
1965	-------	3,613,375	331,050	3,167,122	100,000	1,551,200	8,762,747
1966	-------	2,817,164	292,940	3,311,784	-------	504,275	6,926,173
1967	-------	2,428,503	-------	2,841,754	-------	748,880	6,019,137
1968	-------	3,783,755	-------	3,537,218	80,000	412,360	7,813,333
1969	2,292,977	4,549,223	1,752,400	3,347,289	253,844	659,685	12,855,418
1970	1,481,510	7,482,669	2,062,860	4,150,625	-------	666,930	15,844,594

TABLE 12

RELATIVE PROPORTION OF CHUM RELEASED

Fry and Reared

WILLAPA BAY – GRAYS HARBOR – COASTAL DISTRICT

YEAR	CHINOOK	SILVER	CHUM	TOTAL	% CHUM
1950	1,545,151	889,645	----	2,434,796	
1951	3,467,262	962,961	----	4,430,223	
1952	3,889,507	688,296	----	4,814,260	
1953	4,369,748	1,610,299	----	6,369,407	
1954	1,616,713	1,297,384	----	2,914,097	
1955	3,065,192	1,491,612	----	4,557,804	
1956	2,541,867	1,883,846	----	4,425,713	
1957	4,374,081	1,571,225	----	5,945,306	
1958	2,942,143	3,593,255	1,969,383	8,504,781	23%
1959	3,195,958	1,213,153	1,817,380	6,226,491	29%
1960	4,240,849	1,557,973	2,108,192	7,907,014	27%
1961	717,945	1,739,277	3,653,316	6,110,538	60%
1962	668,160	4,194,355	817,610	5,680,125	14%
1963	1,206,692	1,035,837	1,634,995	3,877,524	42%
1964	2,056,999	2,508,608	1,496,580	6,062,187	25%
1965	3,613,375	3,498,172	1,651,200	8,782,747	19%
1966	2,817,164	3,604,734	594,275	6,926,173	9%
1967	2,428,503	2,841,754	748,880	6,919,137	11%
1968	3,783,755	3,537,218	492,360	7,813,333	6%
1969	6,842,200	5,099,689	913,529	12,855,418	7%
1970	8,964,179	6,213,485	666,930	15,844,594	4%

TABLE 13

RELATIVE PROPORTION OF CHUM RELEASED – WILLAPA BAY

YEAR	TOTAL PLANTED	CHUM	PERCENT CHUM
1957	3,030,553	-0-	-0-
1958	5,973,446	2,404,756	40%
1959	3,056,435	1,652,080	54%
1960	3,564,958	1,215,392	34%
1961	3,932,484	2,587,316	66%
1962	3,571,809	754,610	21%
1963	2,472,056	898,420	36%
1964	3,629,799	1,205,580	33%
1965	5,748,877	1,551,200	27%
1966	4,431,228	504,275	11%
1967	3,527,773	748,880	21%
1968	4,665,202	412,360	9%
1969	7,425,954	685,029	9%
1970	8,976,437	666,930	7%

TABLE 14

SALMON PLANTS - WILLAPA BAY TRIBUTARIES

YEAR	BEAR RIVER	NASELLE RIVER	NEMAH RIVER	PALIX RIVER	NIAWIAKUM RIVER	BONE RIVER	WILLAPA RIVER	SMITH CREEK	NORTH RIVER	CEDAR RIVER	WILLAPA HARBOR
CHUM PLANTS											
1957											
1958			1,648,781				755,975				
1959			1,650,130				1,950				
1960			1,213,392				2,000				
1961			2,433,470				106,260				47,586
1962			614,490				140,120				
1963			898,420								
1964			1,205,580								
1965			1,551,200								
1966											504,275
1967			748,880								
1968			412,360								
1969			659,685				25,344				
1970			666,930								
SILVER PLANTS											
1957	29,042	105,821	226,064	38,275			300,661		59,543		40,000
1958	26,000	116,680	437,561	50,728			801,048		101,702		801,048
1959	15,770	96,612	75,884	24,990			185,598		44,268		114,200
1960		55,880	333,448	8,100			454,582		18,120		35,112
1961			169,965				402,053				218,793
1962	50,500	516,830	636,637				815,661		33,081		196,437
1963		70,312	313,152				23,174		21,250		195,032
1964		53,400	317,980				451,052		45,042		151,776
1965		162,640	357,131				667,130		175,131		72,930
1966		25,050	441,579	40,162			409,092		64,782		550,969
1967			555,946				1,385,997				
1968	42,090	121,258	802,122				765,380		81,862		
1969	97,760	380,640	1,137,610				759,303		97,884		76,400
1970	106,050	733,292	952,617				1,147,014		303,980		134,400
CHINOOK PLANTS											
1957		187,465	896,960	67,060			1,079,752				
1958		98,000	647,963				1,227,705				1,227,705
1959		30,000	583,385				233,648				
1960		18,065	470,039				956,220				
1961			209,235				345,116				
1962			422,285				145,768				
1963			447,138				373,293		30,060		100,225
1964			775,643				629,286				
1965			986,939				1,623,210		50,024		102,542
1966			1,422,455				938,724				34,140
1967			836,950				696,363				
1968			1,266,654				1,172,606				
1969		252,890	1,742,415	117,900			1,541,023		340,600		196,500
1970		242,400	1,286,740				1,834,964		738,870		

The numbers of fish planted from the various hatcheries that have operated in the Willapa Bay drainage are shown in Tables 9, 10, and 11. The streams and area in which these plants were made are indicated in Table 13. References in Table 13 to Black Lake and Johnson Slough are concerned with fish-farming experiments by the Department of Fisheries and will be reviewed later. Table 14 indicate the number of fish planted in each of the major streams draining into Willapa Bay by species since 1957.

Analysis of the results of marking experiments with hatchery fish has led WDF to conclude that a major portion of the harvest of salmon in Willapa Bay is from hatchery stocks. It also indicates that stocks originating in Willapa Bay hatcheries contribute heavily to the ocean fishery.

Chum salmon tend to spawn low in the drainage of tributary streams in the bay and even in brackish water. The location of the existing hatcheries well up in the drainages does not make it likely that they can effectively handle chum salmon. An enlarged hatchery program with chum has been delayed by WDF. This delay has been due to the low appraisal the department has of the economic value of chum salmon to the state, the fact that chum does not contribute to the sport fishery and a lack of the technology needed to develop a major hatchery program in chum.

NATURAL PROPAGATION

With the view that hatcheries can only supplement natural propagation, the legislature and Department of Fisheries initiated a stream improvement program in 1951. The aim of the program was to clear access to spawning beds, protect downstream migrants from various water diversions by use of screens and maintain minimum stream flows. The 1967 legislature provided the Director of Conservation the authority to establish minimum stream flows after consultation with the Director of Fisheries or the Director of Game, however, existing water rights, storage rights, and use by hydro-electric or water storage reservoir plants were not effected.

The removal of splash dams, log jams, beaver dams, and other debris which completely blocked many streams to the migration of salmon, was accelerated. Table 15 lists stream cleanup activities in tributaries of Willapa Bay between 1948 and 1970. The early activities involved initial removal of splash dams and major log jams which provided access to many miles of stream. Latter activities appear as maintenance operations with occasional major removal jobs. These projects were largely involved in the removal of stream blockages. However, as this work began clearcutting became the universal logging practice and stream damage was extreme. The area clearcut between 1950-1974 is depicted in Figure 11 of the Water section of this report. It includes nearly all the spawning stream areas in the Willapa Bay drainage. The damage to fish involves the removal of shade effecting temperature levels and the silting of gravel beds so that they can no longer function as incubation areas. This has been compounded by the practice of

TABLE 15

STREAM IMPROVEMENTS - WILLAPA BAY TRIBUTARIES - 1948-1970

YEAR	IMPROVEMENT	LOCATION
1948	2 log jams removed	East Fork, Naselle Riv.
	2 old splash dams removed	South Fork, Willapa
	1 old concrete dam removed	North River
	1 dam removed	Ferrier Creek
	3 splash dams removed	Palix River
1949	Install fish ladder and culvert baffles	Stringer Creek
1950	2 log jams removed	Middle Fork, Nemah Riv.
1951 & 1952	2 splash dams and several log jams removed-opened 20 miles of stream	Willapa River
	Stream clearance	North & Naselle Rivers
1953	2 splash dams removed	South Fork, Willapa Riv.
	splash dam removed	Higgins Creek
	partial removal splash dam	Naselle River
	2 large log jams removed	North River & Ramie Cr.
1954	No details available	
1955	log jam removed	South Fork, Naselle Riv.
1956	Removed large log jam - opend up approximately 32 miles of stream	N Fork, Naselle River
	small log jams removed on tributaries	Naselle & Bear Rivers
1957	Stream clearance	Salmon Creek & Cedar River
1958	No details available	
1959	No improvements indicated	
1960	No improvements indicated	
1961	Work in Pacific County not detailed	
1962	Obstruction removal - constructed fish passage cement creek	S Fork, Naselle River, & Davis Creek

1963	log jams debris removal	Cement, Bean and Davis Creek, S Fork Naselle River
	log jams and debris removal	Crusher, Dog Salmon Higgins Cr., of S Fork, Naselle, River
	debris removal	Salmon Creek
	debris removal-tributaries	Salmon Creek
	debris removal	Dell Creek
	beaver dam removed	Ellsworth Creek
	beaver dam removed and debris	S Nemah River
	beaver dam removed	Tarlett Slough Cr.
	log jams, debris and beaver dams removed	Williams Creek
	blow down removed	Higgins Cr.-Naselle Riv.
	3 large log jams removed	Middle-Nemah River
	log jams, debris and beaver dams removed	N Nemah River
	log jams-created fishways	Fall River
	debris removed	Smith Creek
	debris and log jams removed	Fishtrap Creek-Willapa
	beaver dams removed	Fredricks I-I, Fleiss Creeks
1964	removed numerous log jams	Alder Cr., (E Fork Naselle River)
	removed large log jam	N Fork, Naselle River
	removed log jams, debirs and beaver dams	N Nemah River
	Debris and beaver dams removed	Bean Creek (S Fork, Naselle River)
	Removed Debris	South Fork, Naselle
	debris removed	Dell & Horn Creeks Naselle River
	Beaver dams removed	Ellsworth Cr. Naselle Riv.
	Beaver dams & debris removed	Salmon and Pietta Cr. Naselle River
	Removed log jam	Bear River
	" " "	Fall River
1965	Beaver dams removed	Tarlett Slough
	Debris removed	Fall River
	Beaver dams removed	S Nemah River
	Beaver dams removed	Ellsworth Cr. Naselle Riv.
	Removed beaver dams	Fleiss Cr. & I-I Creek
	Log jam removed	Smith Creek
	Log jam removed	Williams Creek

1966	Removed log jams & debris	North Nemah River
	" " "	Middle Nemah River
	Windfalls, log jams removed	N Fork Naselle River
	Removed log jams and debris	Savage Creek N Fork Naselle River
	Removed log jams	Alder Creek S Fork Naselle River
	Log jams removed	Bear River
	" " "	Fall River
	Blasted falls for salmon passage	Middle Palix River
	Removed log jams	Ellis & Forks Cr. (Willapa River)
	Log jams removed	Finn Creek (N Nemah River)
	Removed log jams	Ramie Cr. (North River)
	Removed beaver dams, brush, & blow downs	Tarlett Slough
	Beaver dams removed	Pietta & Salmon Creeks (Naselle River)
	Removed beaver dams	Bear, Cement and Davis Creeks, (South Fork Naselle River)
1967	Removed windfalls, debris, log jams	North Nemah River
	Removed two large log jams	South Fork Willapa River
1968	Removed windfalls	Fall River
	Removed windfalls	South Fork Naselle Riv.
1969	Removed debris and log jams	Mill Creek, Willapa Riv.
	Removed log jams, stumps and debris	Williams Creek
	Removed log jams	Nemah River
	Removed beaver dams & debris	Salmon Creek & other Tributaries, Naselle Riv
	Removed debris, beaver dams and windfalls	Redfield Creek (North River)
	Removed beaver dams and debris	Martin Creek (North River)
	Removed beaver dams and debris	Cement, Davis, and Bear Creeks, (South Fork, Naselle River)
	Beaver dams and debris removed	Ellsworth Creek
	Removed beaver dams, windfalls and log obstructions	Trap Creek (Willapa River)
1970	Removed beaver dams	Redfield Creek North River
	Removed beaver dams	Piettta Creek Naselle River
	Removed log jam and debris	Dell Creek, Naselle River

1970 (Cont'd)	Windfalls removed	Stringer Creek Willapa River
	Log jams, beaver dams removed	South Fork Nemah River
	Removed debris	Fall River
	Windfall and Debris removed	Higgins Creek Naselle River
	Log jam, stumps and debris removed	Williams Creek
	Debris removed	Burnham Creek South Fork Naselle River
	Removed old bridge, log jams	North Nemah River
	Log jams removed	North Fork Naselle River
	Debris and Windfalls removed	Salmon Creek " "
	Beaver dams, debris removed	Fleiss, I-I, Electric and Fredericks Creek
	Removed debris and beaver dams	Bean, Davis and Cement Creeks (South Fork Naselle River)
	Beaver dam and debris removed	Ellsworth Creek
	Removed debris	Oxbow Creek Willapa River

the removal of gravel from stream beds for road construction. Stream runoff patterns are also changed producing lower low flows.

The Department of Fisheries estimates that the damage will continue to keep the natural propagation level low for another 10-15 years until there is regrowth of vegetation in the stream areas. All indications are that the current natural propagation of all salmon species in the Willapa Bay drainage is at a very low level.

During the period of activity of stream improvement and presumably added natural propagation little or no improvement was evident in the Willapa Bay fishery, however, at the same time the ocean catch of chinook and silver salmon increased greatly. As noted earlier, if the contribution of the tributaries and hatcheries of Willapa Bay to the ocean fishery are considered, plus the catch in the bay, it appears that the productivity of the bay in chinook and silver must be close to its earliest production levels. At the same time the chum fishery has fallen off disasterously. Hatchery production has not been increased for chum but more significatly chum do not seem to have responded to the stream improvement program. In fact it almost appears that they have suffered from it although there is no direct evidence which would lead to such a conclusion. Possibly the stream improvement program has concentrated on upper drainage problems thus tending to benefit chinook and silver spawning grounds while those more preferred by chum continued to degrade. Some areas worked, however, were known as chum areas and they are not necessarily separate from those of chinook and silver. The loss of the chum fishery has not been limited to Willapa Bay but has occured in other areas sometimes earlier than in Willapa Bay.

FISH FARMING

Milo Moore became Director of the Department of Fisheries in 1957. He instituted a "fish farming" program which involved the rearing of salmon in lakes, ponds and estuaries. The program is described in the 1957 Annual Report of the Washington Department of Fisheries as follows:

> "Less than 30 days after taking over administration of the Department, the Director ordered steps taken to initiate a fish farming program to take advantage of knowledge gained from similar programs in other parts of the world. The practibility of rearing salmon in natural ponds and lakes is an idea shared by many employees of the Department.

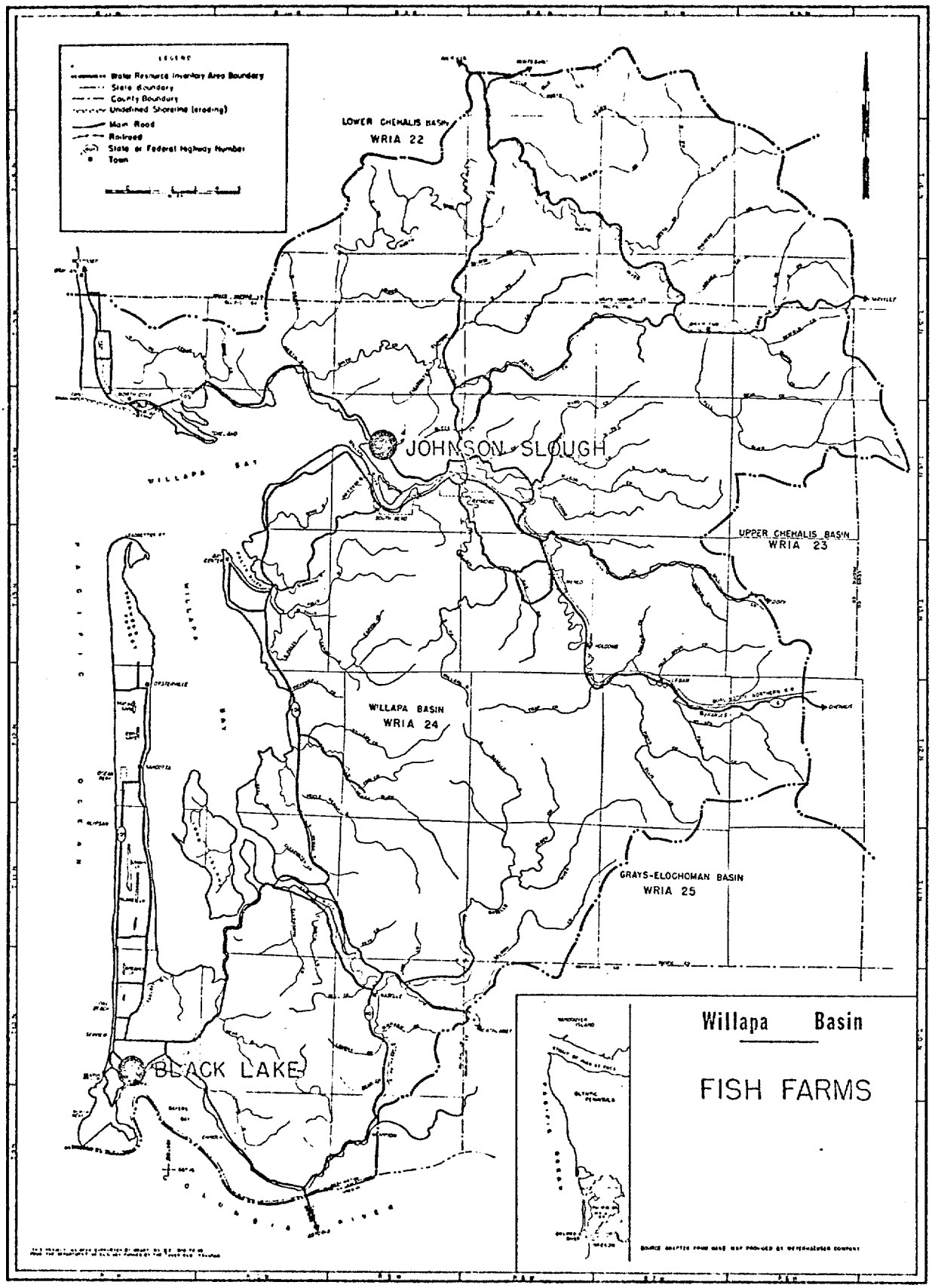

LOWER CHEHALIS BASIN
WRIA 22
JOHNSON SLOUGH
UPPER CHEHALIS BASIN
WRIA 23
WILLAPA BASIN
WRIA 24
GRAYS-ELOCHOMAN BASIN
WRIA 25
BLACK LAKE
Willapa Basin
FISH FARMS

FIGURE 31

TABLE 16

FISH FARM PLANTINGS

JOHNSON SLOUGH				
YEAR	SILVER	CHINOOK	CHUM	SOURCE
1958	60,403			Willapa
1959	50,600			Simpson
1960				
1961	56,245			Lake Pleasant
1961			47,586	Trap Creek
1962	45,000			Johnson Slough
1963	27,002			Bingham Creek
1963		100,225		Deshutes River
1964	40,590			Forks Creek
1965		100,000		Deshutes R. & Forks Creek Hybrids
1966		34,000		Deshutes R. & Forks Creek Hybrids
BLACK LAKE				
1959	63,450			Simpson
1960	35,000			Willapa
1961	150,000			Pleasant Lake
1962	153,000			Black Lake
1963	168,030			Black Lake and Bingham Creek
1964	88,800			Black Lake
1965	-------Plants made--but no numbers available----------			

Compiled from WDF Annual Reports

The success the Department has in the future in restoring salmon production to a higher level for both commercial and sports fishermen will depend to a large extent upon the expansion of the lake, pond and marine estuary salmon rearing program initiated during 1975.----------

During the past year, approximately 1,050 surface acres of fresh water and 35 acres of salt water were developed by the Department of salmon rearing. In general, silver and chinook salmon will be reared in predator-free, mineral and fertilizer improved fresh water, and chum and pink fry will be raised in salt water estuaries that have been freed of predators.----------

The program now under consideration calls for vast expansion. As additional bodies of water become available through direct Departmental purchase, lease easement or permit, more hatchery-incubated fish will be planted into these productive areas and will be reared without loss from predation in planktonic enriched waters until they are ready for ocean existence. With the inclusion of such large lakes os Ozette, Palmer, Big, Samish and Mason, many thousands of acres of water can be producing salmon at a miximum rate. It is highly possible that in the future a sufficient number of hydraulically and environment-controlled rearing areas can be brought into production to increase the Departments present reared salmon output from 60 million to 500 million fry each year."

The fish farming program grew out of earlier experiments in salt water rearing at Hoods Canal. Local areas used for this program were Johnson Slough near the mouth of the Willapa River and Black Lake at Ilwaco.

At Johnson Slough, silvers were planted until 1965 when it was decided that the higher summer temperatures, salt water intrusion and low dissolved oxygen made long term rearing impractical. Chinooks were introduced after 1964 to avoid the summer problems. In 1960 a 10 foot rotating screen was installed at Johnson Slough to prevent the loss of young fish and in 1962, the slough was poisoned to remove undesirable species. Table 16 includes the record of plantings in Johnson Slough.

At Black Lake only silvers were planted and are also recorded in Table 16.

In 1965, WDF sponsored an economic feasability study of the fish farming program. The conclusions from this study were:

"1. Some hope of economic feasability can be obtained by closing down operations in areas where production is demonstrably low.

2. A controlled natural rearing program is unlikely to meet the full test of economic feasability without some effort to enhance the natural productivity of the areas.

3. It would take a large differential in physical productivity to justify expansion of controlled rearing of chum and pink salmon, both of which are relatively low valued in the commercial usage and contribute comparatively little to the sport fishery."

The later statement apparently reflects the Department of Fisheries' policy towards chum salmon, judging from the statement itself, the placement of hatcheries and the production of chum fry.

The fish farming experiment ended in Pacific County in 1966. No more plants were made after that date. The department no longer reported on fish farming after 1966 but did refer to programs in "Natural Rearing Areas".

OTHER SPECIES OF FISH

DOGFISH SHARK

Dogfish shark liver produced oil which was used for illumination and lubrication before electricity and petroleum derivatives were readily available. They did not become an important element in the fishery however, until it was discovered that the livers of the dogfish and soupfin shark contained Vitamin A. By the early 1940's the demand for shark liver was high and lively fishery developed in Willapa Bay, as well as in other coastal areas. The development of synthetic substitutes and the availability of foreign fish oil sources depressed the local market until very few shark were taken for livers after 1950. Figure 32 shows the poundage landed at Willapa Bay. A small portion of this catch was taken outside the Bay. Table 17 shows the relative values of shark livers from 1940 to 1953 to westcoast fishermen.

Dogfish shark are readily caught in gill nets and often occur as an undersireable incidental catch to strugeon and salmon fishing. The lack of value and the damage of nets, large numbers often being caught in a single drift, make them a nuisance to the gillnetter. The intense fishery for them in the 1940's greatly reduced their numbers and when they returned to abundance in the 1950's, considerable concern was expressed that as a predator they would wipe out the food fishery. (See WDF Annual Report 1958). Massive programs were initiated or requested to subsidise the harvesting of dogfish in order to control them. Such attempts are not usually biologically sound.

A market for dogfish may develop if it can fill the need for marine fish protein in hatchery food for salmon. Such a market would probably not be lucrative but if it provided an income for this incidental catch to pay for lost fishing time and gear damage, the dogfish shark would serve to augment the fishery rather than reduce the profitability.

STURGEON

Sturgeon are taken by gill net in Willapa Bay as incidental catch to salmon. They often make up the bulk of the catch during the first few weeks of the gillnet season in July and early August, and appear in catches throughout the season. There has been a minimum length of four feet for sturgeon since 1897 and later a maximum length of six feet was imposed.

Annual catch in pounds is presented in Figure 33. A long term increase in catch peaked at 140,000 pounds in 1971 and has dropped off radically since then. Both green and white sturgeon are taken; the green being the major portion of the catch. Price

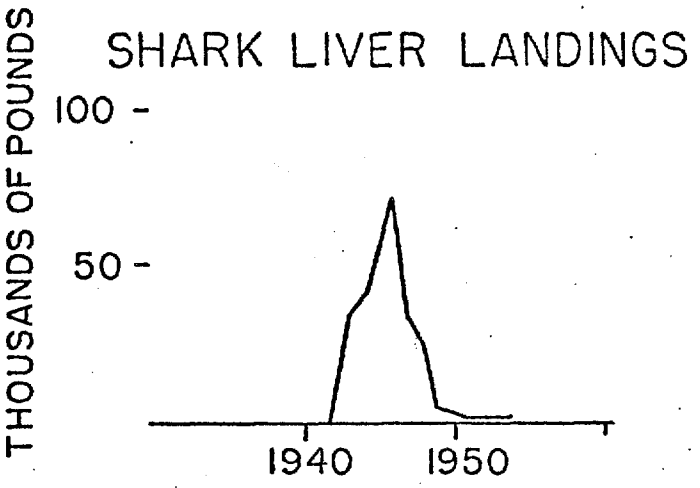


FIGURE 32

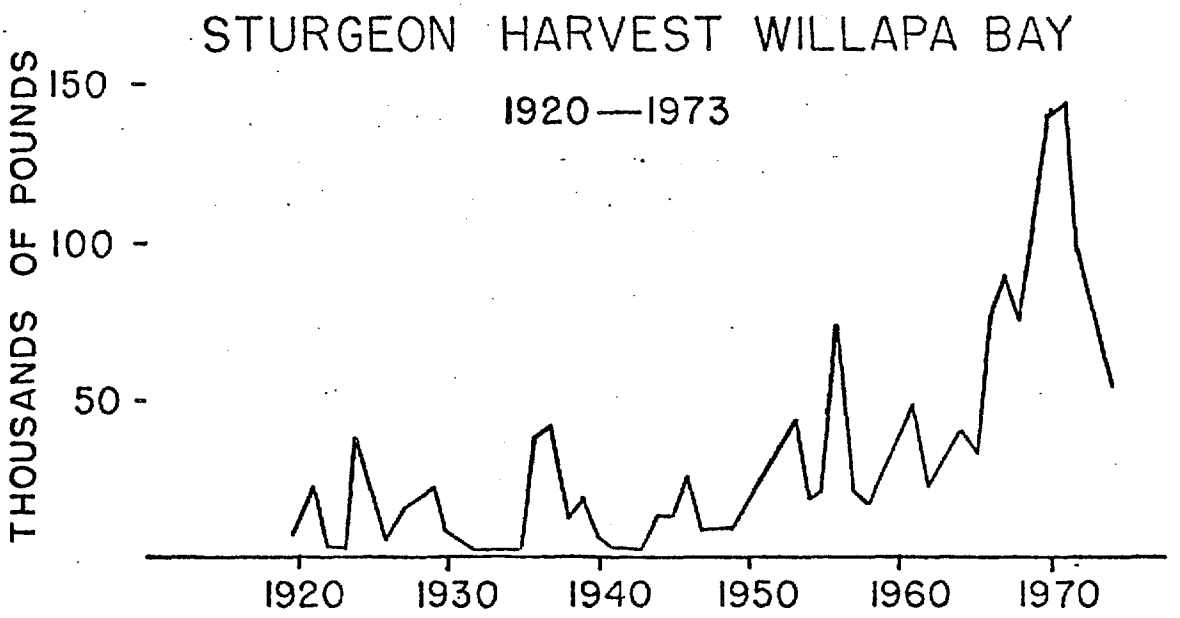


FIGURE 33

Table 17

Total Landings of Dogfish Livers in

Washington, Oregon, California, British Columbia and Alaska

1940-1953

Year	Price per Pound	Pounds of Liver Landed
1940	5.7 cents	1,915,077
1941	26	5,648,703
1942	27	6.468,180
1943	46	8,280,761
1944	44.6	13,542,960
1945	40.2	9,020,188
1946	55.5	6,010,373
1947		6,025,624
1948	56.6	5,145,170
1949	42.5	5,873,185
1950	15.6	766,933
1951	26.5	1,209,468
1952	17.1	1,011,568
1953	10.4	898,900

From WDF Annual reports

and the prevalence of dogfish sharks during the early season effects the sturgeon catch. It is not clear if the drop in catch since 1971 reflects the condition of the resource or some other factor.

OTHER BAY FINFISH

A number of fish other than those already noted are taken sparotically in Willapa Bay. These include shad, anchovy, white bass, smelt, herring and flounder. The baitfish are not regularly taken primarily because only a small number of sport and troll boats operate or make landings in Willapa Bay. Baitfish, however, are often in high abundance within the bay. A small shad fishery operates occasionally in the bay. Flounder and rarely white bass are taken as incidental catch in gill nets but are usually not marketed.

The potential for expansion of catches in these fish has not been pursued.

OCEAN FISH LANDED AT WILLAPA BAY

Small amounts of troll salmon are landed in Willapa Bay. Occasionally trollers interrupt their salmon fishing to catch tuna. This occurs when warmer ocean water moves northward and shoreward, usually in late August, so that smaller boats can enter the tuna fishery (See Table 1).

Bottom fish occur as incidental catch to crab and shrimp in recent years. Incidental catch to crabs does not enter the market. Large amounts of bottom fish, 1,500,000 pounds in 1973, are taken in shrimp trawls. Since 1972 a black cod fishery has developed out of Willapa Bay and takes about 200,000 pounds each year. Some ling cod and red snapper occur as incidentals in the black cod traps. Outside fishery is important to the bay fishery because of its potential ability to fill out the season for fishermen and processors.

SUMMARY

The predominent characteristic of the finfish fishery is its high variability from year to year in production. This makes it difficult to recognize short term trends, however in Willapa Bay it is clear that there has been a decline in the total salmon catch beginning in the late 1950's. This decline is attributed largely to the reduction in the catch of chum salmon which formerly represented 71% of the number of salmon caught.

The actual number of fishermen in the bay has remained relatively stable but the declines in numbers of fish caught results in a lowering of the fish to potential gear ration.

The natural propagation of chinook and silver salmon has been severely reduced by habitat damage due to logging practices. Artificial propagation of chinook and silver salmon has increased through the expansion of existing facilities. Most of the current harvest in Willapa Bay is from these facilities. At the same time the ocean fishery for chinook and silver has increased greatly both in the numbers of fish caught and in the amount of sport and commercial gear in use particularly in the areas through which fish pass on their return to Willapa Bay. The increase in the resource has not benefited the bay fishery.

There has been very little effort towards artificial propagation of chum and this effort has diminished over recent years. The development of the Japanese high seas net fishery for chums in the Bering Sea area coincides with a major reduction of chum catch in the mid 1950's along the coast of North America. Chum returns to hatcheries has declined in recent years while that of chinook and silver have significantly increased.

The local gillnet fishery has been reduced to a position where they are allowed only those fish not taken by the ocean fishery which has continually expanded and those fish not needed for propagation. Increasing the number of fish propagated and reared as juveniles in the bay both naturally and artificially will not necessarily benefit the local fishery as long as other elements of the fishery are not limited in their opportunity to catch fish before they can return here. Although there is a potential to increase the number of fish produced, the larger question is who will benefit from this increase and will the local fishery be further limited in order to provide the spawning material for this increase.

A low fish to gear ratio indicates an inefficient fishery and forces a higher price for the fish produced. Regulation philosophy in the past has been to leave the fishery open but limit seasons and gear in such a way that it is inefficient. Higher cost of fish results in higher market price and may limit the marketability of the product and thus become a more serious problem than who gets the fish.

There is little chance of change in the present harvest level until vegetation is reestablished in stream areas. Reduction in the ocean fishery could provide some increase in the Willapa Bay harvest.

RAZOR CLAM FISHERY

The commercial Razor clam harvest in Pacific County averaged over one million pounds per year until quotas were invoked by the Department of Fisheries in 1942. In 1950, the Pacific County ocean beaches were closed to commercial razor clam digging. The spits in the mouth of Willapa Bay were left open to commercial clam digging. At the time the Pacific County beaches were closed to commercial razor clam digging over 2500 licenses were held cach year. Twenty to thirty percent of the reported clam harvest was used for crab bait, (See Figure 34 & 35).

The recreational razor clam harvest has varied widely from one to six million clams per year on each of the north and south county ocean beaches. The average appears to be around two and one half million clams from each area. (See Figure 36 & 37). The number of diggers has increased from 250,00 digger trips in the late 1940's to about 650,000 digger trips in recent years for all the Pacific Ocean beaches, Grays Harbor and Pacific County. Local numbers have varied between 100,000 and 200,000 for each of the Pacific County areas for the last ten years.

Sampling and counts by the Department of Fisheries indicate that the wastage of clams by diggers ranges from twenty to thirty percent of the total taken by recreational diggers and three to five percent by commercial diggers.

A commercial hardshell clam fishery grew to over 250,000 pounds a year in Willapa Bay in the 1950's, but dropped off to less then 50,000 pounds per year after 1960. These clams were primarily taken by oystermen from their beds.

The razor clam provides another example of the conversion of a resource in Pacific County from primarily a commercial utilization to largely a recreational utilization.

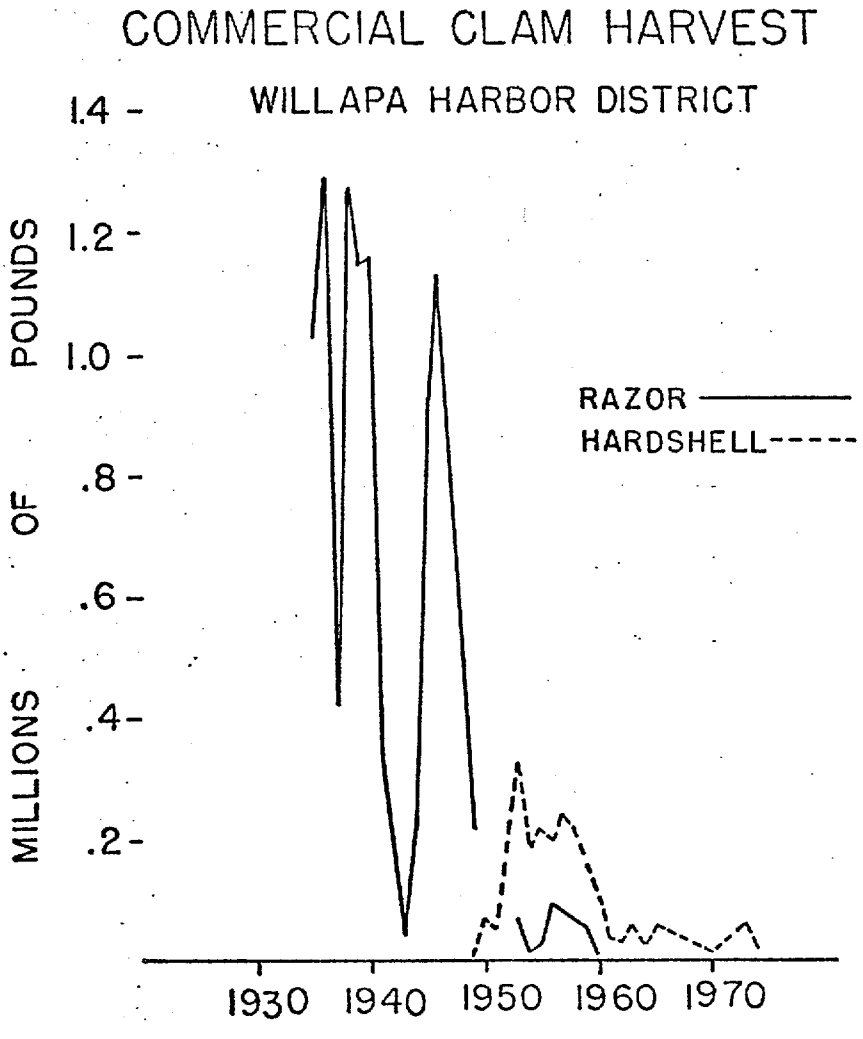

COMMERCIAL CLAM HARVEST
WILLAPA HARBOR DISTRICT
MILLIONS OF POUNDS
1.4
1.2
1.0
.8
.6
.4
.2
RAZOR
HARDSHELL
1930
1940
1950
1960
1970

FIGURE 34

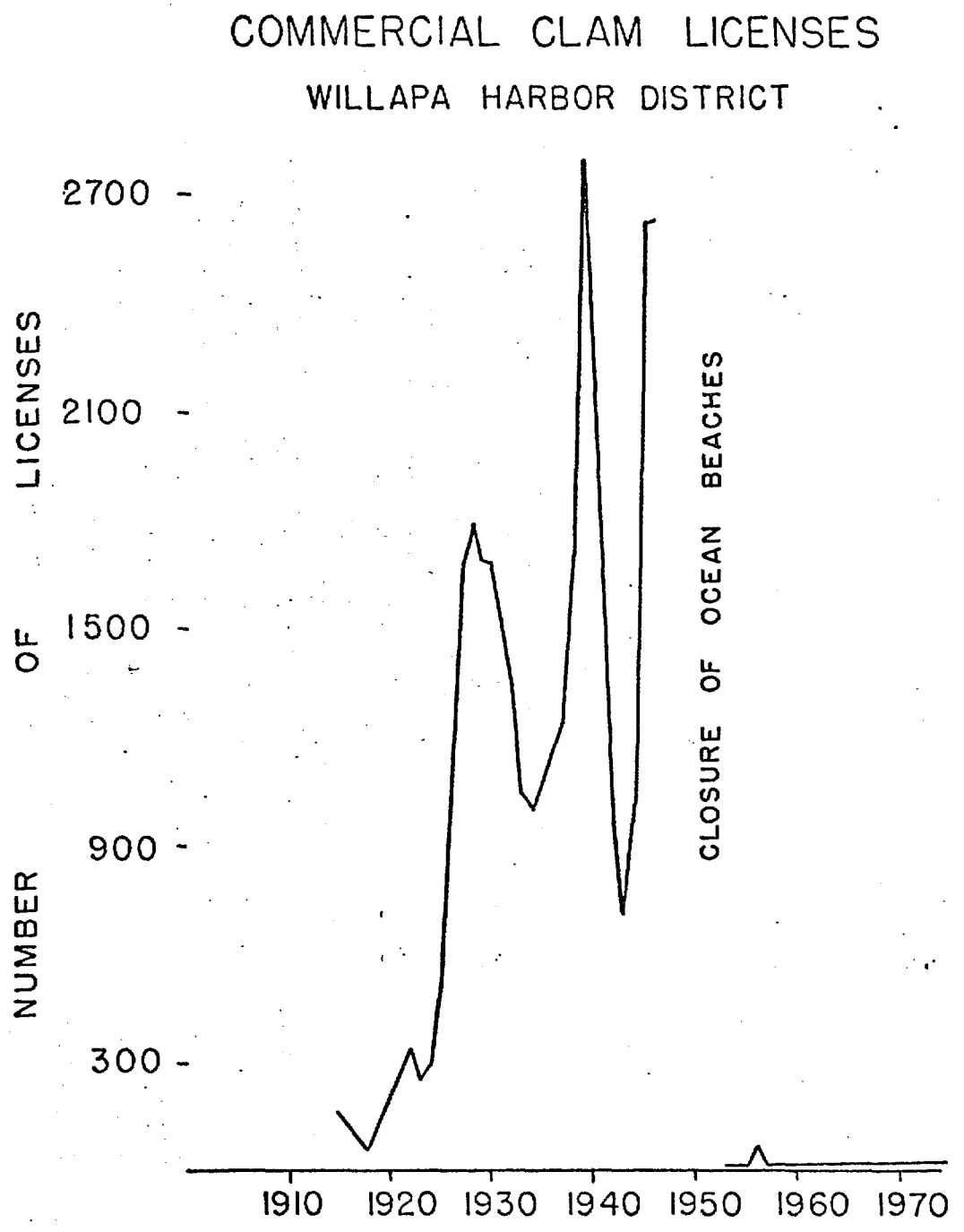

COMMERCIAL CLAM LICENSES
WILLAPA HARBOR DISTRICT
NUMBER OF LICENSES
2700
2100
1500
900
300
CLOSURE OF OCEAN BEACHES
1910
1920
1930
1940
1950
1960
1970

FIGURE 35

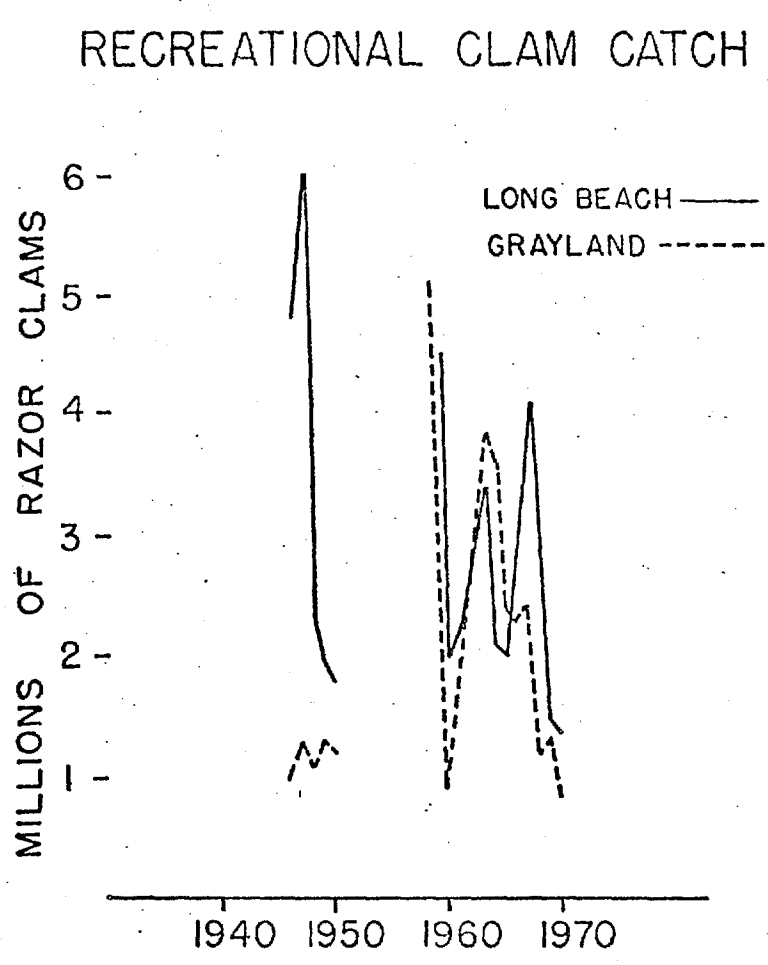

RECREATIONAL CLAM CATCH
MILLIONS OF RAZOR CLAMS
6
5
4
3
2
1
LONG BEACH
GRAYLAND
1940
1950
1960
1970

FIGURE 36

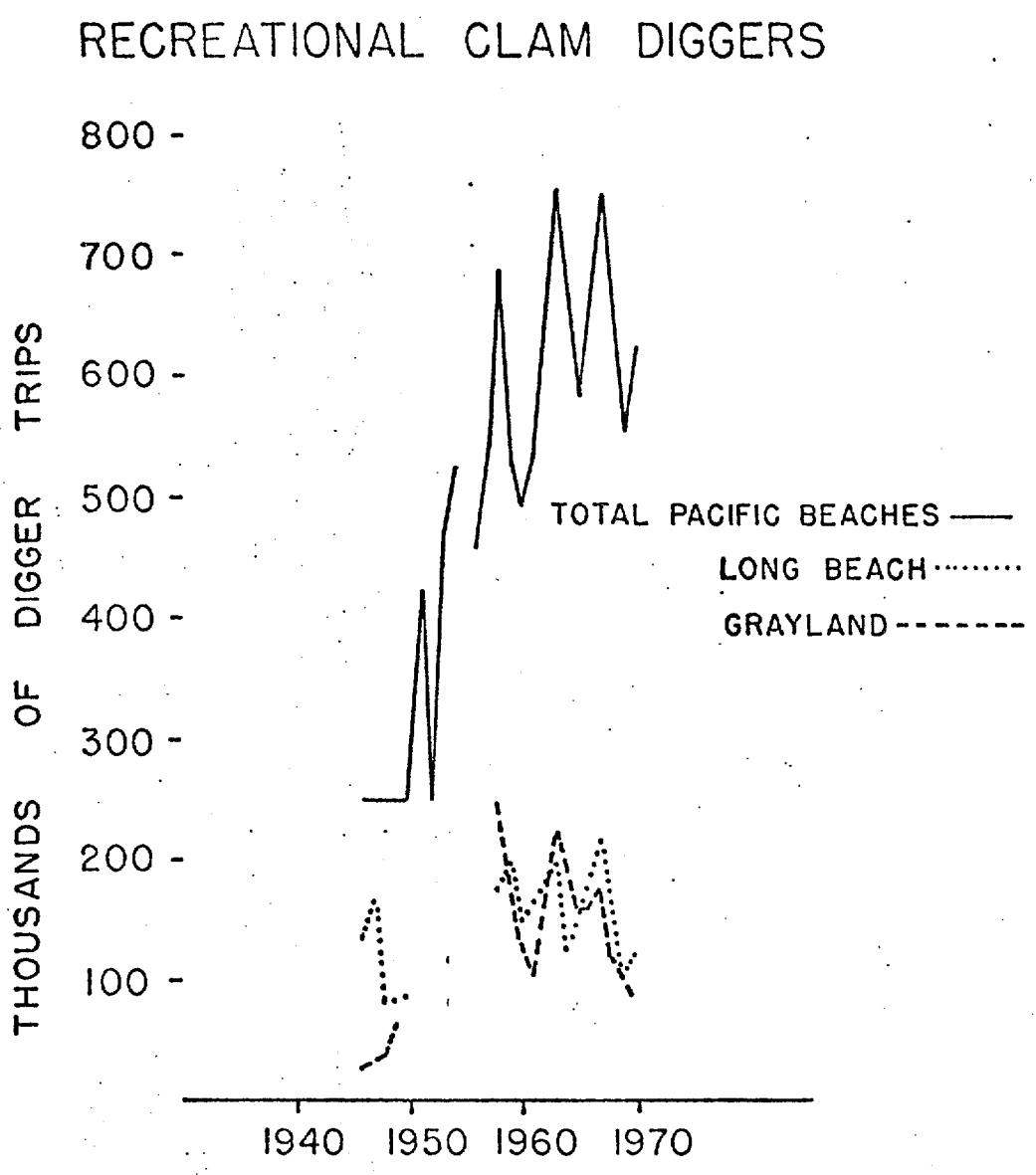

RECREATIONAL CLAM DIGGERS
800 -
700 -
600 -
500 -
400 -
300 -
200 -
100 -
THOUSANDS OF DIGGER TRIPS
TOTAL PACIFIC BEACHES
LONG BEACH
GRAYLAND
1940
1950
1960
1970

FIGURE 37

TABLE 18

COMMERCIAL CLAM HARVEST
Willapa Harbor District
Pounds

Year	Razor	Hardshell
1935	1,028,261	
1936	1,280,474	
1937	424,708	
1938	1,265,040	
1939	1,145,661	
1940	1,577,114	
1941	340,659	
1942	221,374	
1943	46,285	
1944	213,435	
1945	931,000	
1946	1,125,549	
1947	849,779	
1948	518,731	
1949	217,396	1,471
1950		67,995
1951		47,539
1952		205,520
1953	60,267	323,788
1954	11,961	186,174
1955	24,666	216,698
1956	92,947	195,643
1957	79,814	237,581
1958	58,003	218,856
1959	47,693	170,687
1960	190	82,127
1961	36	32,669
1962		24,651
1963		58,925
1964		21,473
1965		47,583
1966		57,259
1967	647	54,962
1968		32,037
1969		21,711
1970	148	10,239
1971	126	17,165
1972		21,557
1973		27,062
1974		12,177

Data from WDF Reports

TABLE 19

RECREATIONAL RAZOR CLAM DIGGING

Year	Long Beach No. Clams	Long Beach No. Diggers	Grayland No Clams	Grayland No. Diggers	All Beaches Total
1946	4.8	134,000	1.0	28,000	250,000
1947	6.0	167,000	1.3	35,000	250,000
1948	2.3	79,279	1.1	38,800	250,000
1949	2.0	83,610	1.3	61,558	250,000
1950	1.8	83,000	1.2	60,000	250,000
1951					422,000
1952					250,000
1953					468,000
1954					522,181
1955					
1956					459,000
1957					546,000
1958		175,000	5.1	246,000	684,000
1959	4.5	197,000	2.1	162,000	525,000
1960	2.0	149,000	0.9	135,000	490,000
1961	2.25	157,000	1.3	100,000	534,000
1962	2.9	183,000	2.9	172,000	683,000
1963	3.4	192,000	3.8	213,000	750,000
1964	2.1	120,000	3.6	208,000	641,000
1965	2.0	127,000	2.4	154,000	583,000
1966	3.3	185,000	2.3	159,000	682,000
1967	4.1	215,000	2.4	173,000	750,000
1968	2.6	159,000	1.2	120,000	634,000
1969	1.5	100,000	1.3	100,000	554,000
1970	1.37	120,000	0.85	87,000	622,000

Data from WDF Reports
Number of Clams expressed in millions
Number of diggers expressed in "digger trips"

CRAB FISHERY

The Dungeness Crab is a major fishery resource in Washington. Although it is primarily harvested in the ocean, Willapa Bay is a significant harvest area as well as serving as a nursery for these crabs. Currently there are three crab processors at Willapa Bay ports.

Crabs move about considerably so that it is likely that the catches landed at the Columbia River, Willapa Bay and Grays Harbor are all derived from the same population. Free swimming crab larvae are hatched early in the year and have developed to juveniles by June. In the course of their growth crabs discard their old shell through moulting as they increase in size since the shell does not grow. Harvested crabs are from three to four years old.

The 1905 legislative session closed the season on crabs from July through September each year and set the minimum size to be kept at six inches. The Fisheries Code produced by the 1915 legislature made it unlawful to keep females and increased the minimum size to 6 1/2 inches. The minimum size was reduced by the 1927 legislature to 6 1/4 inches and the beginning of the season was set back to June.

The Department of Fisheries, by director order in 1942, reversed the season for crabs so that it was open from June through September rather than closed as before and closed October through December. Presently the season is usually open from January through September 15. There are no regulation limiting the amount of gear in the fishery or the number of crabs taken.

The total catch of crab landed in Southwestern Washington has varied in a cyclic manner with peaks about every 10 years. Until 1940 about 70 percent of the crab landings were made in Willapa Bay ports. Crab harvest records do not segregate bay crabs from ocean caught crabs. After 1940 the proportion of the crab catch landed at Willapa Bay ports was reduced considerably with increasing landings at Grays Harbor. After 1950 landing in Washington Columbia River Ports increased, those in Willapa Bay were reduced further and Grays Harbor remained at about the same level. Currently 20-25 percent of the catch is landed at Willapa Bay ports, about the same amount at Washington Columbia River ports and 50-60 percent is landed at Grays Harbor. Figure 38 illustrates the total catch for Southwestern Washington ports from 1935-1974. Figure 39 indicates the proportion of the catch landed at Willapa Bay, Grays Harbor and Washington Columbia River ports.

Crab licenses have followed similar trends as those of harvest and are shown in figure 40.

There is presently no economic system for the artificial enhancment of the crab fishery by means of hatcheries etc. Protection of females and early developmental stages of the young provides the available areas of improvement and maintenance of the resource. This requires protection of nursery areas, Willapa Bay being one of these.

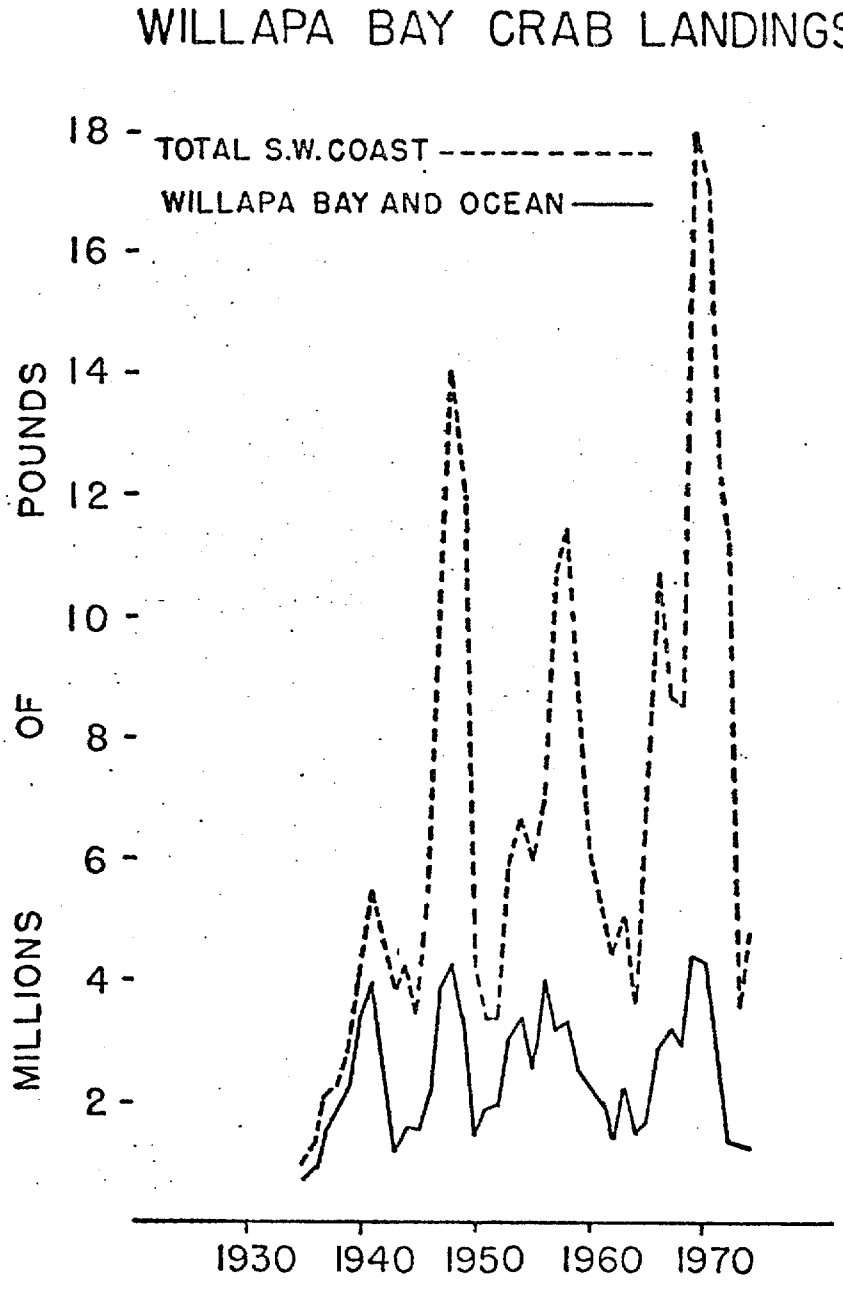

WILLAPA BAY CRAB LANDINGS
TOTAL S.W. COAST
WILLAPA BAY AND OCEAN
MILLIONS OF POUNDS
18
16
14
12
10
8
6
4
2
1930
1940
1950
1960
1970

FIGURE 38

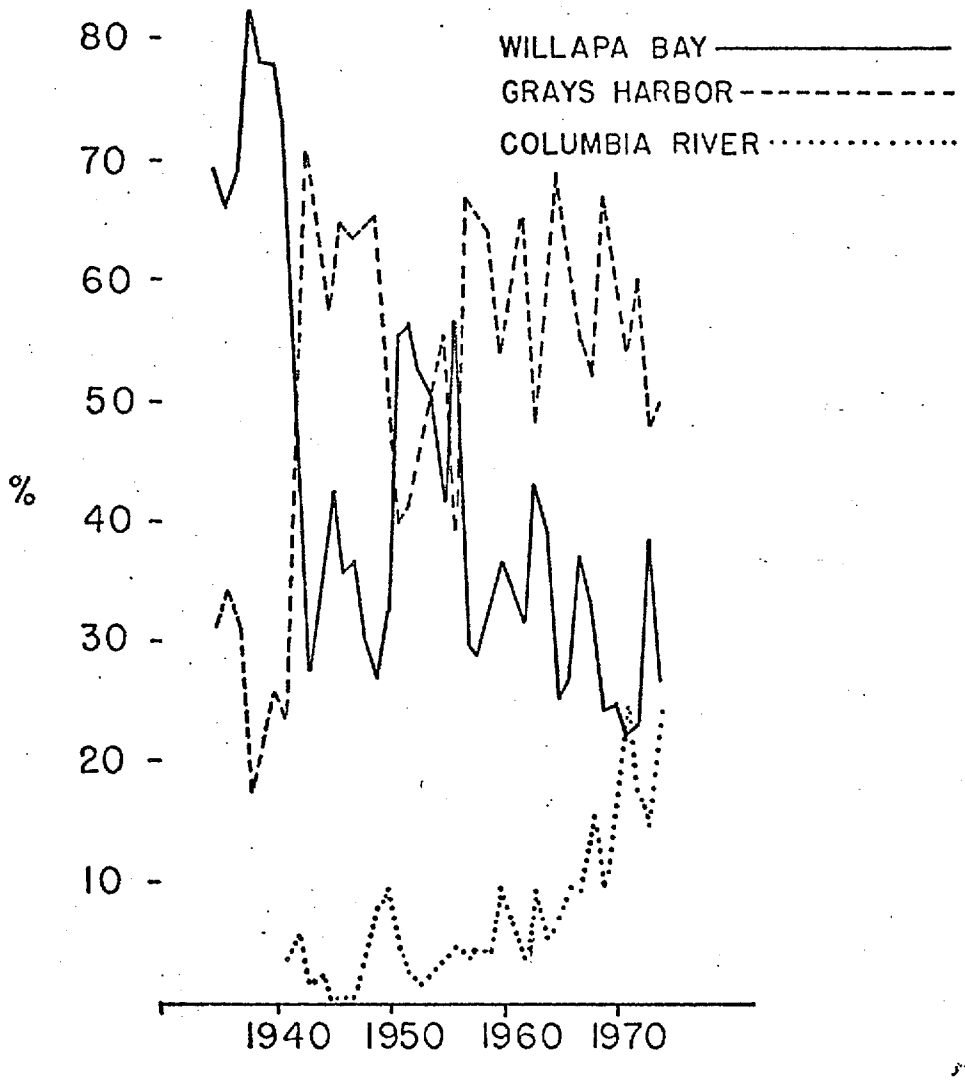

CRAB LANDINGS S.W. WASH.
PROPORTION BY AREA
WILLAPA BAY
GRAYS HARBOR
COLUMBIA RIVER
%
80
70
60
50
40
30
20
10
1940
1950
1960
1970

FIGURE 39

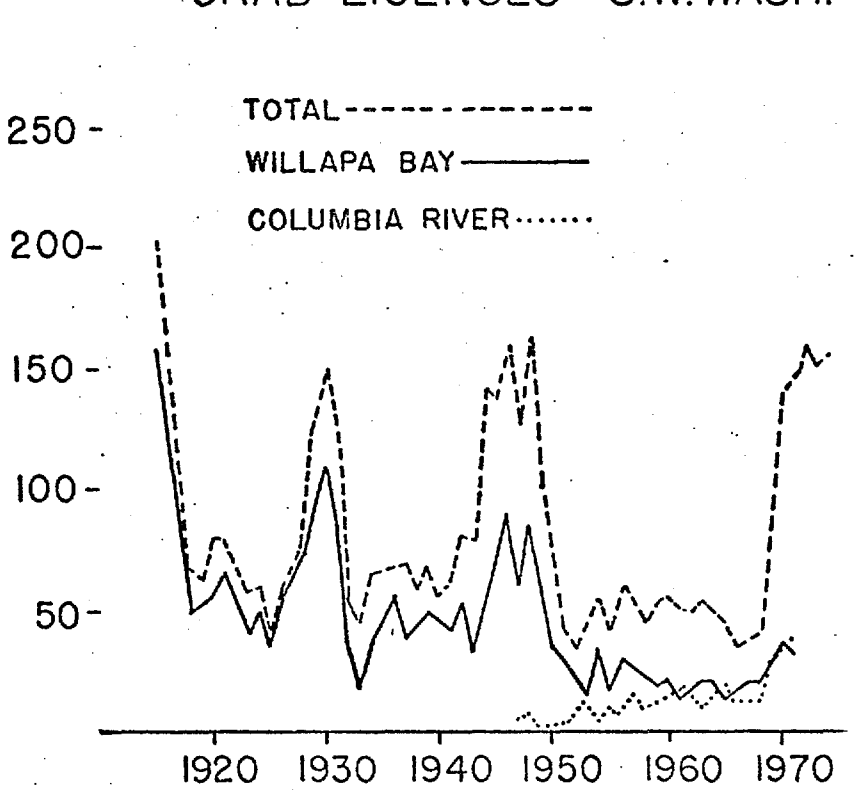

CRAB LICENSES S.W.WASH.
TOTAL----------
WILLAPA BAY———
COLUMBIA RIVER·····
250 -
200-
150 -
100 -
50 -
1920
1930
1940
1950
1960
1970

FIGURE 40

TABLE 20

CRAB LANDINGS IN POUNDS

Year	Columbia R.	Willapa Bay	Grays Harbor	Total
1935		684,842	312,166	997,008
1936		865,194	451,890	1,317,084
1937	3,428	1,441,352	643,231	2,088,011
1938		1,831,716	387,728	2,219,444
1939		2,153,496	620,004	2,773,500
1940		3,341,754	1,134,182	4,475,936
1941	207,164	3,968,152	1,293,222	5,468,538
1942	249,304	2,134,818	2,262,696	4,646,818
1943	56,660	1,052,550	2,732,090	3,841,300
1944	83,326	1,529,196	2,622,316	4,234,838
1945	4,838	1,439,204	1,961,978	3,406,020
1946	17,474	2,031,544	3,674,536	5,723,554
1947	38,184	3,822,288	6,599,880	10,460,352
1948	615,738	4,233,108	9,074,602	13,923,448
1949	950,006	3,204,240	7,694,806	11,849,052
1950	399,440	1,375,788	2,469,894	4,245,122
1951	154,970	1,830,528	1,321,496	3,306,994
1952	82,580	1,892,842	1,373,708	3,349,130
1953	78,263	3,035,435	2,700,206	5,813,904
1954	191,177	3,333,543	3,118,840	6,643,560
1955	209,871	2,457,479	3,269,131	5,936,481
1956	329,386	4,082,936	2,832,842	7,245,164
1957	386,931	3,196,881	7,174,757	10,758,569
1958	691,725	3,300,403	7,473,607	11,465,735
1959	341,602	2,446,493	4,900,608	7,688,703
1960	600,344	2,222,101	3,286,508	6,108,953
1961	346,488	1,912,222	3,211,354	5,470,064
1962	158,633	1,372,678	2,854,597	4,385,908
1963	469,533	2,204,679	2,470,892	5,145,104
1964	187,917	1,406,497	2,004,662	3,599,076
1965	402,292	1,643,301	4,496,120	6,541,713
1966	1,064,182	2,882,102	6,826,676	10,772,960
1967	809,523	3,177,958	4,686,657	8,674,138
1968	1,297,712	2,810,513	4,413,521	8,521,746
1969	1,705,655	4,341,330	11,979,868	18,026,853
1970	2,952,006	4,226,699	9,982,940	17,161,645
1971	2,999,471	2,756,766	6,758,808	12,515,045
1972	1,942,177	2,577,661	6,716,113	11,235,951
1973	485,921	1,312,368	1,636,148	3,434,437
1974	1,145,758	1,256,199	2,363,628	4,765,585

Data from various WDF Reports

TABLE 21

PROPORTION OF CRAB CATCH BY AREA

Year	Columbia R.	Willapa Bay	Grays Harbor
1935		69.0	31.0
1936		66.0	34.0
1937	0.2	69.0	30.8
1938		82.5	17.5
1939		77.7	22.3
1940		74.7	25.3
1941	3.8	72.6	23.6
1942	5.4	46.0	48.6
1943	1.5	27.4	71.1
1944	2.0	36.1	61.9
1945	0.2	42.3	57.5
1946	0.3	35.5	64.2
1947	0.4	36.5	63.1
1948	4.4	30.4	65.2
1949	8.0	27.0	65.0
1950	9.4	32.4	58.2
1951	4.7	55.4	39.9
1952	2.5	56.5	41.0
1953	1.4	52.2	46.4
1954	2.9	50.2	46.9
1955	3.5	41.4	55.1
1956	4.6	56.4	39.0
1957	3.6	29.7	66.7
1958	6.0	28.8	65.2
1959	4.4	31.8	63.8
1960	9.8	36.4	53.8
1961	6.3	35.0	58.7
1962	3.6	31.3	65.1
1963	9.1	42.9	48.0
1964	5.2	39.1	55.7
1965	6.2	25.1	68.7
1966	9.9	26.8	63.3
1967	9.3	36.6	54.1
1968	15.2	33.0	51.8
1969	9.5	24.1	66.4
1970	17.2	24.6	58.2
1971	24.0	22.0	54.0
1972	17.3	22.9	59.8
1973	14.1	38.2	47.6
1974	24.0	26.4	49.6

TABLE 22

CRAB LICENSES

Year	Columbia R.	Willapa Bay	Grays Harbor	Total
1915	5	160	38	203
1916	13	129	8	150
1917	4	96	13	113
1918	2	56	10	68
1919	5	52	5	62
1920	11	55	15	81
1921	2	65	11	78
1922	1	51	14	66
1923	4	40	13	57
1924	3	51	6	60
1925	1	35	5	41
1926	1	54	3	58
1927		64	2	66
1928	1	75	7	83
1929	2	97	32	131
1930	4	110	35	149
1931	3	86	35	124
1932	1	37	17	55
1933	2	18	23	43
1934	1	37	27	65
1935				
1936		56	10	66
1937		37	31	68
1938		43	15	58
1939		49	18	67
1940		46	9	55
1941		43	18	61
1942		54	27	81
1943		32	47	79
1944		52	89	141
1945		68	70	138
1946		90	69	159
1947	5	60	61	126
1948	8	86	68	162
1949	1	62	40	103
1950	1	35	35	71
1951	2	28	11	41
1952	5	21	9	35
1953	15	15	16	46
1954	5	33	17	55
1955	10	18	11	39
1956	7	30	21	58
1957	16	26	12	54
1958	10	22	12	44
1959	13	19	21	53
1960	15	20	19	54
1961	17	14	19	50
1962	16	18	14	48
1963	10	21	22	53
1964	16	20	12	48
1965	18	14	11	43
1966	13	16	6	35
1967	14	20	6	40
1968	13	20	6	39
1969	29	29	30	88
1970	33	36	70	139
1971	39	32	71	142
1972		72	86	158
1973		72	79	151
1974		75	79	154

Data from WDF Reports

1972-74 Columbia R licenses included in Willapa Bay or Grays Harbor

NUMBERS OF FISHERMEN INVOLVED IN PACIFIC COUNTY FISH AND CRAB LANDINGS

By combining the salmon season in the mid summer through fall with the crab season in the winter a commercial fishermen may put together his total yearly income from fishing. His salmon season fishing may be by gillnet, troll or charter. He may have a boat which can be used for both salmon and crab or may use two boats, one gillnetter and a larger crab boat, or he may only have a gillnetter and crew for another fisherman on crab. Many of the smaller crab boats are operated by one man. The thirty to forty footers usually have a skipper and one man while the larger boats usually have at least two men and the skipper.

Many fishermen fish only salmon by gillnet, troll or charter and have some other type of employment for the remainder of their income. Some of these are oystermen. In a very good year they make their entire income from salmon , however they will be classified here as part time fishermen.

A number of sport fishermen buy commercial licenses to circumvent the limits in number of fish. Usually these are troll licenses however some get gillnet licenses and jump into the season if it looks particularly good. These are recognizeable by the combination of a troll license on too small a boat, etc. These fishermen then do not depend on fishing for any significant portion of their income and will be referred to as casual here.

Pacific County Resident Fishermen

Using the above criteria and examining the license records for Pacific County residents it is indicated that there are 60 full time fishermen, 243 part time fishermen and 49 casuals who live in Pacific County. This method however shows fishermen who crew for somone else during crab season as part time. Examination of the records indicates that 81 positions are available on crab boats for the part time fishermen so the total full time should be considered to be 141 and the part time 162. A number of fishermen own more fishing boats than they can handle themselves, that is several gillnetters or trollers or charter boats etc. There are 31 such boats, 5 of which supply fulltime

employment. The remaining 26 would supply only part time employment. The totals then appear to be 146 fishermen who recieve all their income from fishing and 188 who recieve less than all their income from fishing. Some of the part time probably should be recognized as full time in that they also fish in other states to fill out their income for instance Alaska or Oregon.

TABLE 23

License Combinations held by Pacific County Residents

License combinations for boats

Crab only	11
Charter only	40
Troll only	129
Gillnet only	127
Troll and Gillnet	16
Troll and Crab	21
Gillnet and Crab	16
Charter and Troll	7
Charter and Crab	3
Gillnet, Crab and Troll	7

Fishermen may have more than one boat, combinations of multiple boat and license combinations are as follows:

2 Troll	3
3 Troll	0
2 Charter	3
3 Charter	1
2 Gillnet	6
3 Gillnet	2
1 Gillnet, 1 Troll	2
1 Troll, 1 Crab	0
1 Gillnet, 1 Crab	11
2 Gillnet, 1 Crab	2
1 Charter, 1 Crab	1
2 Troll, 2 Crab	1

Licenses may be held for more than one district. Examples of such combinations amoung Pacific County Fishermen are as follows:

Troll 2 Districts	2
Troll 3 Districts	0
Gillnet 2 Districts	5
Gillnet 3 Districts	2
Crab 2 Districts	0

TABLE 24

1975 Commercial Fishing Licenses

Held by Pacific County Residents

License	Grays Harbor Distict 2		Willapa Bay District 3		Totals	
	Pac. Co.	Total	Pac. Co.	Total	Pac. Co.	Issu
Gillnet	11	295(4)	156	407(38)	167(24)	702
Troll	67	1148(6)	105	497(21)	172(10)	1645
Crab	7	87(8)	51	72(71)	58(36)	159
Dip Bag	0	29	2	51(4)	2(3)	80
Set Line	4	25(16)	5	10(50)	9(26)	35
Charter	1	211(.5)	50	139(36)	51(15)	350

() indicates percent of total held by Pacific County Residents

Columbia River licenses are now included in either Grays Harbor (District 2) or Willapa Bay (District 3) licenses. A commercial fisherman who wants to fish out of the Columbia River may do so with either a District 2 or 3 license. Fishermen who wish to fish in Willapa Bay must have a District 3 license. However this license also allows them to fish in the Columbia River for instance; thirty eight percent of the potential gillnet fishermen in Willapa Bay are residents of Pacific County, twenty four percent of the potential gillnet fishermen in the Columbia River are residents of Pacific County, etc. (see table 24).

Non-Pacific County Residents

Table 24 indicates that only 32% of the Willapa District licenses were held by Pacific County residents in 1975. This indicates that there is a sizeable number of fishermen who are non-residents of Pacific County but make some portion of their income from Pacific County landings either in Willapa Bay or at Washington Columbia River ports. In addition Table 2 also indicates that only 5% of the Grays Harbor district licenses were held by Pacific County resident fishermen.

Under the dual area license a Grays Harbor license allows Columbia River fishing priviliges so that there must also be a number of non-resident fishermen making landings at Washington Columbia River ports holding Grays Harbor licenses. An attempt will be made here to estimate the size of the non-resident group deriving part of their income from Pacific County landings.

Before the imposition of dual licenses fishermen commonly purchased a combination of Willapa and Columbia River or Grays Harbor and Columbia River licenses since two licenses were required. An estimate of the number following this pratice may be made by comparing 1971 license figures (last year that single area licenses were in effect) and the 1975 figures used above. Comparison of the two periods reveals that the totals of licenses purchased for these Southwest Washington areas dropped between 1971 and 1975 for troll and gillnet licenses, the types of fishing were area switching is the most common. Since this was a period when limited entry considerations were involved few if any fishermen did not reneue licenses. The drop then must reflect the number who held licenses for more than one district in 1971 but were not required to in 1975 in order to still retain the same fishing prévileges. For instance a fisherman who held a Columbia River and a Willapa license in 1971 needed to purchase only a Willapa District license in 1975. The same would be true for a Grays Harbor-Columbia River combination. The totals for Columbia River, Willapa and Grays Harbor licenses for 1971 and 1975 are as follows:

License	1971	1975	Difference
Troll	2056	1645	411
Gillnet	802	702	100

The above table and discussion suggest that 411 of the fishermen who held troll licenses for the Columbia River in 1971 also held a license for Willapa or Grays Harbor. Since 1082 troll licenses were issued for the Columbia River in 1971 it appears that 671 (1082-411) were for fishermen who primarily landed their fish in Washington Columbia River ports. In the same year only 90 troll licenses were issued for the Willapa District and 884 were issued for Grays Harbor. In 1975, since a single area Columbia River license was not available, 671 more fishermen were required to buy either a Willapa or Grays Harbor license in order to fish in the Columbia River District. Apparently 407 of these licenses were purchased as Willapa and 264 as Grays Harbor.

Year	Total	Willapa	Columbia River	Grays Harbor
1971	2056	90	1082	884
(adjusted)	1645		671	
1975	1645	497	(671)	1148
Diff.	411	407		264

Previously it was noted that 105 of the 497 Willapa District troll licenses were held by Pacific County residents (Table 2). This leaves a balance of 392 licenses for non-residents. From the approach applied above it appears that an additional 197 troll licenses (264-67 residents) were probably held by non-residents to be used for Columbia River landings giving a total of 589 troll licenses used by non-resident fishermen for landings in Pacific County ports. It was estimated in examining the Pacific County resident fishermen licenses that 15 of the 172 troll licensed were probably casuals and derived little or none of their income from fishing. If the same proportion (9%) of the non-Pacific County residents holding troll licenses are casuals then 536 of the total non-residents were serious fishermen and derived a significant of their income from Pacific County troll landings.

If the same process is applied to gillnet licenses the following results are obtained:

Year	Total	Willapa	Columbia River	Grays Harbor
1971	802	210	367	225
Adjusted	702		267	
1975	702	407	(267)	295
Difference	100	197	(267)	70

Of the 407 Willapa licenses 156 were held by residents leaving a balance of 251 for non-residents. Of the 70 Grays Harbor license which appear to be primarily Columbia River 11 were held by Pacific County residents leaving a total of 59 non-residents and a total non-residents figure of 310. Casuals were estimated at 20% for residents and if appied to non-residents leaves a balance of 248 non-resident fishermen deriving some part of their income from Pacific County gillnet landings.

Crabbers and charter boat operators do not make practice of jumping from one part of the fishery to another and so the non-resident portion is simply the difference in the total and resident fishermen. In the case of crab licenses 21 are non-resident and with charters 89 are non-resident.

Estimates of the total non-Pacific County resident fishermen who derive part of their income from Pacific County landings are as follows:

Troll	536
Gillnet	248
Crab	21
Charter	89
TOTAL	894

The above analysis and calculations involve several assumptions and manipulations which are subject to error. The purpose was to provide an estimate of the magnitude of non-resident benefit in the commercial fish harvest in Pacific County. The results should not be taken literally but are better expressed as a major factor probably involving 800 or more persons. Gillnet involvement for the non-resident may be only a few days fishing wereas the troll, crab and charter involvement is probably a full season and thus a major portion of the licensee's income. Conversion of the fi-

gures to full time and part time as was done with the Pacific County resident fishermen is not meaningful however it can be pointed out that the non-resident involvement will include more people than indicated where crew other than the skipper is involved, such as in charter and crab, and these crew members may be Pacific County residents.

A comparison of non-resident involvement in the Pacific County fishery is illustrated below:

Pacific County	Resident	Non-Resident	%Non-Resident
Troll	761	172	589	77
Charter	139	50	89	64
Gillnet	477	167	310	65
Crab	72	51	21	29

Conclusions

It appears that the benefits in the form of income recieved from landings of fish and crab at Pacific County ports are realized to more non-Pacific County residents than to those fishermen who live here. Only in the case of crab are more than one half those involved locally based fishermen. Although some non-residents have always been involved in the local harvest the increase probably reflects the change of the fishery from a local inshore operation to an offshore troll and charter catch.

DEVELOPMENT OF REGULATION OF THE COMMERCIAL FISHERY

LEGISLATIVE HISTORY

The first state legislature created the position of the Fish Commissioner whose duties were to: enforce the laws for the propagation, protection and preservation of food fishes and oysters; to build, operate and manage hatcheries, examine complaints concerning the fishery and prepare an annual report to the Governor on the condition of the fishery including suggestions as to the needs of further legislation. The commissioner was appointed by the Governor with the advice and consent of the Senate. The legislature determined through session laws the seasons, gear limitations, and other regulatory matters.

The 1893 legislature broadened the duties of the Fish Commissioner to the collection of license fees and granting of licenses.

An ex-officio Board of Commissioners was created by the 1895 legislature. The board consisted of the Governor, State Treasurer, and the Fish Commissioner.

The 1897 legislature delegated the power to the Fish Commissioner to reserve state lands from public use to preserve the production of Natural Oysters.

The 1899 legislature gave the Fish Commissioner the authority to close any stream or river to fishing when he determined that the protection of the food fish required it. A thirty (30) day notice of such action was necessary. The State Oyster Commission including the Governor, Commissioner of Public Lands and the Fish Commissioner was created by the 1903 legislature. The commission had the responsibility of management and development of state oyster reserves. The 1909 legislature acted to protect game fish but did not delegate the enforcement of the resulting laws.

The first complete fisheries code was enacted by the 1915 legislature. Authority to close streams and rivers was placed in the commission rather than the commissioner. The director and his enforcement personnel were made peace officers, with the authority to arrest without writ, order or process, violators of the fisheries code. It also provided the commissioner the power to inspect canneries, boats, nets, wheels, traps and all property used in catching, packing, curing, preparing or storing food or shellfish and authorized entry in any property at any time for any such purpose. The power to confiscate and sieze unlawful or unlicensed gear was granted as well as the right to file liens against fishing applicances and property

related to inadequate fishways. The Fish Commissioner was granted authority to destroy predators and was made ex-officio state game warden in the 1915 session laws. The 1915 session expanded the commissioner's duties to cover game fishes. The Department of Fisheries and Game was created by the Administration Code in the 1921 Legislative Session. The department was organized into the State Fisheries Board and two division: the Division of Fisheries and the Division of Game and Game Fish. The Fish Commissioner became the Director of Fisheries and Game. The board consisted of three (3) citizens appointed by the Governor.

The fisheries board had the power to investigate habits, supply and economic uses and to classify food fishes and to make, amend and promulgate rules and regulations governing the taking of food fishes, formerly a power excerised by the legislature through session laws. They were also granted the power to develop rules and regulations governing the posession, disposal and sale of food fishes in the State of Washington. These rules and regulations could cover fishing seasons, fishing areas and gear. Former statutes covering food fishes were repealed and constituted as rules and regulations of the state fisheries board and could be modified or revoked by the board. These regulatory actions of the board were to be published in an Olympia newspaper. The Director of the Department of Fisheries and Game was deputized to appoint assistant directors known as the Supervisor of Fisheries and Game through the division of fisheries assumed the powers and duties of the Fish Commission and Fish Commissioner.

The 1923 legislature granted the power to issue permits for the sawing of logs in such waters where no injury to food of game fish would result. A section of the fisheries code made it otherwise unlawful to pass sawdust, shavings, wood pulp or waste into waters of the state. The 1927 legislature extended the authority to the State Fisheries Board to promulgate rules and regulations concerning the placing of refuse and waste in the State's waters to protect aquatic life.

The Directors of Fisheries and Game was granted all the powers and duties of the State Fisheries Board by the 1929 legislature.

In response to Initiative Measure No. 62, a separate Department of Game was created by the 1933 legislature. A Department of Fisheries was created and its chief executive officer to be the Director of Fisheries, a position filled by appointment of the Governor. The Department of Fisheries was organized into the State Fisheries Board and the Director of Fisheries. All powers and duties previously performed by the Director of Fisheries and Game were transferred to the Director of Fisheries. The 1939 legislature extended the director's powers to promulgate rules and regulations to cover the use of food or bait, and again extended these powers in 1941 to include shellfish harvesting, quotas, areas and gear not including privately owned or leased oyster beds or the oysters grown there. The permit granting powers of the Department of Fisheries to be extended to cover hydraulic works by the 1943 legislature, and further extended enforcement powers to include

search without warrant, and sieze food fish or shellfish unlawfully caught.

At the same session the director was authorized to refuse any license if the party applying had a previous license revoked.

It also included economic welfare of the state as a basis for rules and regulations governing the taking of food and shellfish. The 1945 legislature extended the economic welfare discretionary powers of the Director of Fisheries in the act governing the sale of oysters from state oyster reserves. "To maintain the premanency of local communities and industries, the prospects of fulfillment of contract requirement, and to restrain monopolistic controls endangering competition in the industry, the Director of Fisheries shall have the power to determine the number of bushels which shall be sold to any person, firm or corporation; and when sold at public auction, the right to reject any and all bids". In order to implement this policy, the director was granted the right to promulgate rules and regulations governing the conduct of sales.

The power to make and enforce rules and regulations to prevent the spread and the suppression of all infection, contagious dangerous and communicable diseases and pests affecting oyster and other shellfish was granted the director by the 1945 legisalture.

The 1947 legislature granted the director of fisheries authority to acquire lands by purchase, lease or condemnation for the use of the department thus giving the power of Eminent Domain. The same session authorized the director to accept money or real property from other governmental units. The 1951 legislature designated fish inspectors as one of the enoforcement groups with authority to control and regulate traffic on the ocean beachs.

The 1955 legislature granted the director authority to sell, lease, convey or grant concessions upon any property, real or personal, heretofore, or hereafter acquired for the state and under the control of the department.

The 1967 legislature created the Water Pollution Control Commission. The Director of Fisheries was designated as a member. The 1967 legislature also created the Department of Water Resources--Director of Fisheries member of the advisory council.

The 1969 legislature prohibited the Director of Fisheries department from selling spawned out salmon or salmon in spawning condition for human consumption but allowed the director to give them to state institutions or to economically depressed people. Those salmon not fit for human consumption, as found by the Department of Health, could be sold by the director for animal food, fish food or for industrial purposes. The 1971 legislature authorized the director of issue permits for the taking of food fish or shellfish for propagation and cultivation

and to sell salmon eggs for use in fish farming.

The 1973 legislature required the Director of Fisheries to promulgate rules and regulations in accordance with the Administrative Procedures Act rather than simply publishing them in an Olympia newspaper.

The 1974 legislature also authorized the director to refuse licenses for commercial salmon fishing vessels in order to limit the amount of gear in an area.

CURRENT REGULATORY ENVIRONMENT

As reviewed above, the fishery was one of the first commercial activities in Washington to be regulated. It has received considerable attention from the legislature in every session since 1889. Acts concerning the fishery occupy thirty six (36) pages in the Revised Code of Washington. Over three hundred and fifty regulations are concerned with the commercial fishery in the Washington Administrative Code and the Director of Fisheries has issued over twelve hundred orders. Eleven Initiatives to the People have been filed and four Initiatives to the Legislature have been filed concerning various aspects of the commercial fishery. Early regulation, as described above, was almost entirely originated in the legislature. Gradually the administrative office or board administrating the fishery was given the authority by the legislature to regulate more and more aspects of the fishery. In 1921 the authority to promulgate regulations, which became law, was delegated to the administration of the fishery.

The Department of Fisheries thus now has considerable legislative authority, it has its own police force, and can refuse entry to the fishery. It has the power of Eminent Domain. It may use reasons of propagation, preservation or economy to invoke new laws and it also has the responsibility of determining the basis for such reasons. The Department of Fisheries was not required to adhere to the Administrative Procedures Act of the late 1950's until 1973 and thus often did not appear to be responsive to the reactions of the users of the resource or the public. The director of the department acquired the reputation of something of a benign dictator. The department is responsible for the management of a highly exposed and sensitive resource in which thievery is a way of life and often poorly disguised. The combination of legislative, and police powers with research responsibilities within a single administrative unit may never allow any degree of credibility to develop.

The
OYSTER INDUSTRY
of
WILLAPA BAY

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PREFACE

This report has been prepared to provide background information necessary to make decisions in the conservation of the fishery resources of Willapa Bay. A strong historical emphasis is intended in order to supply a perspective for current concerns about the fishery. The intent is to supply a factual basis for evaluating past and future actions related to the oyster industry in Willapa Bay and to develop goals for these actions.

The preparation of this report was financially aided through a grant from the Washington State Department of Ecology with funds obtained from the United States Department of Commerce and appropriated for Section 305 and 306 of the Coastal Zone Management Act of 1972 (G-75-025D and G-76-025B and G-77-025B).

Data for this report was acquired from the Washington Department of Fisheries, Washington Department of Natural Resources, National Marine Fisheries, Pacific County Accessor and Pacific County Auditor. Some data summaries were taken from the "Pacific Fishermen" now incorporated in the "National Fishermen". All of the maps and graphs with the exception of diking districts and production areas are original with this report.

Prepared by J. A. Shotwell, Planning Division
Department of Public Works, Pacific County

OYSTER LANDS

INTRODUCTION

Land suitable for the cultivation of oysters is as important to the oysterman as it is to the farmer on the upland. Bottom characteristics, range of salinity, temperature variation, height within the tidal range, and nutrient levels of the water which periodically covers the land, are some of the factors which determine the capability of a given plot of land to produce marketable oyster. All of these factors are subject to changes which are outside the control of the oysterman. Some are changes resulting from variations in natural phenomena while others are due to the activities of man.

The right to occupy, use or own tideland varies from one area of the United States to another. In some areas, particularly on the east coast, tideland has remained in public ownership and access to the resource is available to all. Under such a system the oysterman is not a farmer but simply a harvester of the oysters. He cannot benefit from improvements which he might make to increase the yield or quality of the oysters which grow on those tidelands. In these areas public agencies often seed and control the harvest to maintain the level of production but publicly owned tidelands have seldom matched the production of deeded and intensively farmed private tidelands. They are completely dependent on the vagrancies of the managing public agency and not on the need to produce a crop at a profit.

A variation of the use of public lands is the granting of leases which allows the oysterman to be a farmer rather than just a gatherer. Inequities and abuses arise in this system due to the terms of such leases either in the renewal requirements or in the rights of abandonment and subleasing.

Where tidelands have been sold the deeds provided usually contain restrictive clauses as to the use of the land or the state retains certain rights such as minerals or access across the lands involved. Reversionary and cancellation clauses are also often included. Subtidal lands are almost always retained by the state, and certain areas are exempted from sale within the tidelands. Many of these retained lands are available for leasing. This is essentially the system that has developed in Washington.

HISTORY OF OYSTER LAND LEGISLATION

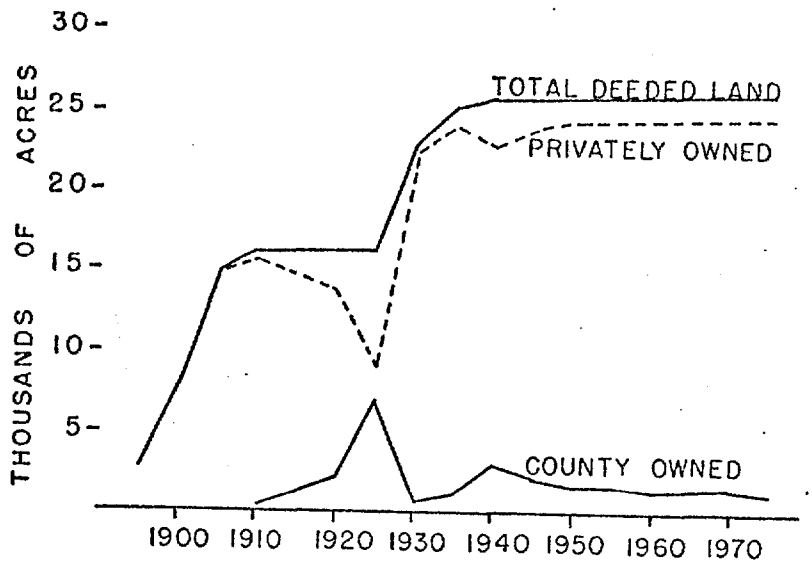
In Washington, prior to statehood, oystermen occupied tidelands which they seeded and worked. These lands were referred to as "artificial oyster beds" in contrast to "natural oyster beds" which could not be exclusively held. These natural beds

were used as sources of seed. Undoubtably the distinction between these types of beds was a moot question in many cases but it was later used as a basis for prior rights. Its basis in territorial law is not clear. In Willapa Bay these occupied artificial beds were designated by names probably reflecting the first occupation of the particular plat. Such names as Captian Johnson's Oyster Bed, Wachsmuth's Stackpole Harbor Oyster Bed, Clark's Deepwater Bed, Clark's Big Stony Point Bed, etc, reflect this early practice. At statehood the Washington constitution claimed all tidelands as property of the state. However the first legislative session (1889-90) acted to allow the sale of tidelands and gave oystermen who had planted lands the exclusive right to purchase those occupied lands up to a total of 80 acres. Such rights of purchase were transferable.

The 1895 legislative session produced an act which was designed primarily to meet the needs of oystermen. It provided for the sale of state tidelands to be used exclusively for the planting of oysters and contained a reversionary clause to cancel the deed if the land were not used for the culture of oysters. The price for such lands was placed at $1.25 per acre. The occupant of a given plot of land had the prior right of purchase for a period of six months after the act was passed. A survey was required and could only include the actual lands then occupied. A limit of 100 acres per purchase was established. Natural oyster lands or reserved lands could not be purchased under this act. If lands were found to be no longer useable for oyster culture the occupant could file for abandonment and make new purchases. In another act passed in the same 1895 session natural oyster beds could be purchased if they had been continuously planted and cultivated as artificial bed since 1890. Only 40 acres could be claimed under this act and the reversionary clause included a provision that the state could take the lands at any time by repaying the purchase price and the cost of improvements.

The 1897 legislature acted to insure the continued public use of natural oyster beds by requiring the Commissioners of Public Lands to survey and plat natural oyster beds and reserve them from sale or lease. Subsequent legislative sessions; allowed lands below extreme low tide to be leased (1899), allowed oyster land owners to purchase the reversionary rights held by the state (1919 & 1925), permitted the sale of lands between existing plats (1919), extended the use of oyster beds for the cultivation of any edible shellfish (1919), and allowed the state land commissioner to sell or lease state oyster land under certain conditions (1929).

A new public lands act was produced by the 1927 legislative session. It included many provisions concerning tidelands suitable for oyster culture which existed in previous legislation. It did not contain provisions of the 1895 oyster bed acts. Detached tidelands were no longer handled differently than other state lands. A provision for the sale of small plots of oyster lands between existing plats similar to the one in the 1919 legislation was retained. All state lands sold under the 1927 act were deeded with a limiting clause which retained the oil, gas and mineral rights for the state.



DEEDED OYSTERLAND 1895-1975

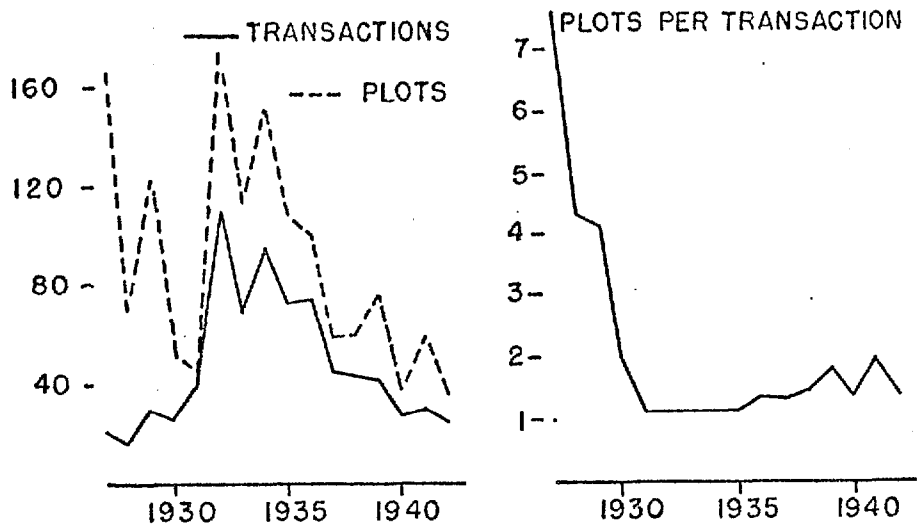
FIGURE 1

The 1935 legislative session repealed the 1895 legislative acts covering the sale of oyster lands but preserved the rights which had been acquired under the original act.

BACKGROUND AND METHODS

From 1895 to 1909 nearly fifteen thousand (15,000) acres of land were purchased for the culture of oysters in Willapa Bay. By 1915 the total had reached sixteen thousand (16,000) acres. The decline of the oyster industry over the next ten years removed the need for additional land and new purchases about equalled cancellation of deeds. At the same time many plots were abandoned and allowed to revert to county ownership through foreclosure on taxes. By 1927 nearly seven thousand (7,000) acres of oysterland, forty three (43) per cent of the deeded land, was held by Pacific County. At this time the Japanese Oyster was introduced in Willapa Bay in an effort to replace the failing native oyster industry as well as the failures in eastern oyster transplants. Current land ownership patterns and trends then have their beginning in the late twenties. The available land for developing what was essentially a new oyster industry consisted of previously deeded land still in privated ownership, oysterland held by Pacific County and potential state tideland still in state ownership. (Figure 1)

In Willapa Bay the oysterlands are identified by tax lot number. This number consists of a letter followed by a number.

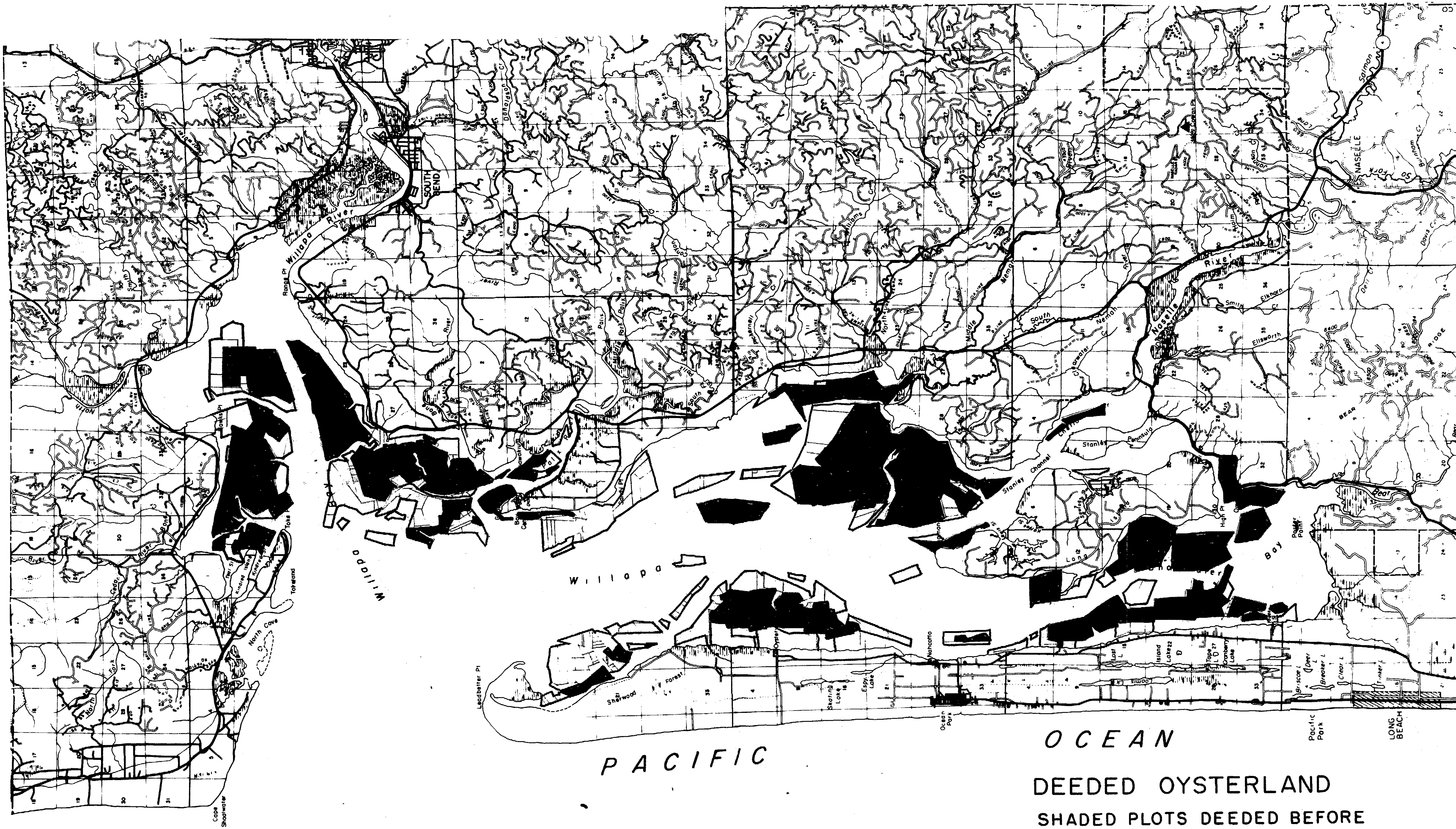


OYSTERLAND OWNERSHIP CHANGES 1927-1942

FIGURE 3

The letter refers to the general geographic location of the plot and the number identifies the plot within that area. (See Figure 14). "A" area is the lands adjacent to the mouth of North River west to the mouth of the Cedar River and Toke Point and north of the channel of the Willapa River. "B" area includes the tidelands south of the Willapa River channel along the east side of the bay south to the south end of the Bay Center Peninsula (Sandy Point). "C" area begins at the southerly end of the "B" area and extends south along the east side of the Bay and Long Island into the lower reaches of the Naselle River and Long Island Slough. "D" area extends from Nahcotta south along the west side of the bay and west side of Long Island into South Bay. "E" area is the tidelands from Leadbetter Point south to Nahcotta along the west side of the bay. These area designations will be used in the following discussion and tabular material.

The following analysis of oysterlands is largely based on a study of ownership patterns. A search was made of the available tax records in the office of the Pacific County Assessor (Art Wood) and the deed and transaction records in the office of the Pacific County Auditor (Robert M. Johnson). Their cooperation is very much appreciated. An effort was made to find all the transactions in the form of deeds and contracts which could provide useful data. Abstracts of ownership changes and the dates were prepared for each of the more than 1200 plots of oysterland in Willapa Bay. These abstracts were filed according to Tax Lot number and area.



DEEDED OYSTERLAND

SHADED PLOTS DEEDED BEFORE 1930

FIGURE 2

A cross index was prepared for state deed application numbers and a file was developed of transactions organized by deed book numbers and pages. This later file was a primary base for the construction of abstracts and provided the source information for recognizing block trasactions referred to in the following study. Not all transactions and deeds were found. Those missing items are noted in the appropriate files which were developed. The abstract file now contains between 4,000 and 5,000 entries.

The application of these data to particular aspects of the study is further described in the appropriate places in the course of the analysis.

OWNERSHIP CHANGES

Prior to the late 1920's land suitable for the cultivation of oysters was largely handled between oystermen. The occupant requirements for the acquisitions of state tidelands, the failing oyster industry, and the limitations of the use of the land for shellfish culture only, had not attracted speculators. With the introduction of the Japanese oyster the prospects for oysterland speculation increased. The action of the 1927 legislature which allowed state tidelands to be sold under the same conditions as any other state lands, the large amount of county owned oysterland, the apparent phenomenal growth of the introduced Japenense oyster, the possibility of its natural reproduction in the area and the probability that this oyster could be farmed by more mechanical means created a very attractive environment for speculation in land. It also created an oyster industry that could handle large areas of land rather than one limited to the small plots which could be worked by hand. Those who recognized the opportunities early determined the land ownership patterns in the industry for many years to come.

Figure 3 illustrates the number of transactions involving oysterland for the period 1927 through 1942. It also indicates the number of plots which changed ownership during the same fifteen year period. FIgure 3 uses the same date but presents it as average number of plots which changed ownership per transaction. It is shown that the number of plots per transaction was high in 1927 and dropped to a level in 1931 which changed very little afterwards. The period 1927 to 1931 represents the time in which large blocks of county oysterland were acquired in a few transactions whereas the later period reflects the sale of these plots and the acquisition of state tidelands which were typically small, often single plot ownership changes. These transactions also include the transfer of ownership of deeded oysterlands which had not been allowed to go for taxes in the early 1920's. The prime source of oysterland for these sales however was the county owned oysterland. It was land which had been previously used for the culture of native and eastern oysters and was available in large blocks and was cheap.

Gerald T. Mogan acquired nearly six thousand (6,000) acres of county oyster land, in 12 transactions involving 138 plots, between 1927 and 1935 for an average cost of $0.38 per acre. During the same period Mogan acquired an additional nineteen hundred (1900)

TABLE 1

COUNTY OYSTERLAND SALES TO G. T. MOGAN

DATE	NO PLOTS	ACREAGE	PRICE	PER ACRE
3/23/27	30	1944.44	165.00	0.08
7/7/27	24	780.94	144.00	0.18
12/29/27	24	393.51	196.45	0.50
3/5/28	10	569.91	582.41	1.02
5/9/28	8	180.37	44.35	0.25
10/20/28	3	249.56	105.00	0.42
11/8/28	4	50.33	75.84	1.51
3/30/29	1	29.23	5.00	0.17
10/15/29	18	696.32	258.12	0.38
9/2/32	7	164.76	47.50	0.29
3/25/35	5	426.97	420.00	0.98
3/25/35	4	377.13	188.50	0.50
TOTALS	138	5863.48	2232.17	0.38

acres of state tideland for a total of nearly eight thousand (8,000) acres. Table 1 includes the county land sales and Table 2 summarizes the distribution by area (A,B,C,D, OR E) of both the state and county lands acquired by Mogan. He had acquired 35% of the deeded land in the bay by 1935.

TABLE 2

COUNTY AND STATE OYSTERLANDS

Acquired by G. T. Mogan

AREA	COUNTY	STATE	TOTAL
A	895.28	702.57	1,597.85
B	1,565.59	346.39	1,911.98
C	2,269.53	732.33	3,001.86
D	812.25	0.00	812.25
E	320.83	63.86	384.69
			7,708.63

Oystermen purchased some of the county lands but with exception of Espy, who bought a little over 500 acres, and the Ilwaco Oyster Company which purchased a similar amount, their purchases were less than one hundred acres. Mogan acquired the bulk of the available land. He was not the only land dealer during this early period of the Japanese Oyster Industry in Willapa Bay. A number of others including: Fireside Realty, Noton Company, Bruer Brothers, Ernest Steffen, etc., dealt in land acquired in the same way as was Mogans or with land purchased from Mogan. None of them had the influence on land ownership pattern that Mogan did because of his extensive holdings but they operated in much the same way.

Mogan retained three thousand five hundred (3,500) acres of land in three large blocks. One of these blocks was set up as Willapa Oyster Farms, Inc., one as Bay Point Oyster Farms, and the other was unnamed but later (1953) became the land of Union Fishermans Coop. Each of these blocks was over one thousand acres. Over one thousand acres were sold to individuals in the same plots that they were acquired. Thirteen hundred acres were sold to oystermen also in their original plot boundaries. Eight hundred and fifty acres eventually went back to the county for taxes. One thousand acres were set up in small blocks called oyster gardens and subdivided into small tracts (2 to 10 acres in size). This Subdivisions of oysterland will be discussed in more detail later. Mogan formed the Willapa Development Company to sell lots in the oyster gardens. Mogan's largest "garden" was the Nemah Pacific 315 acres. This was formed into Nemah Pacific Oyster Inc. and apparently disposed of by Mogan since he does not appear as an officer in that corporation in 1933. The Willapoint Oyster Company was apparently set up by Mogan as a processing plant for oysters harvested from the large blocks of retained lands, but no lands were deeded to this company.

Oysterland was subdivided in much the same way as other land is. Single plots were divided into a number of small tracts or several adjacent pieces were combined and then divided into a large number of tracts. The total number of tracts varied from three to two hundred twenty four for a subdivision. Many of the subdivisions were given names such as, Willapa Oyster Gardens, Seagold, Willabay, Hawks Point, Sandy Point, Nema Pacific, but more often referred to simply by the tax lot number of the original piece or pieces of ground. Recorded subdivisions used tract numbers or letters for the tracts created but few subdivisions were recorded so that the new tract created was usually given a new tax lot number. Eighty subdivisions of oysterland have been made in Willapa Bay. Nearly six thousand acres of tideland were subdivided into eight hundred tracts. The tracts were equally divided between land deeded before 1929 and after.

Of the original purchasers of these tracts oystermen accounted for only about 15% of the tracts. The remainder were sold to individuals in Washington, Oregon, California, Idaho, Montana, Wisconsin, Minnesota and Iowa, et. The original cost of the lands to the subdividers was less than $2.00 per acre and often less than $1.00 per acre. Sale prices, where they are available, indicate that the tracts were sold at from $250 to $500 per acre. Not many tracts were actually put into oyster production, and many of them have changed hands six to eight times and some as many as ten. Thirty five percent of them have been abandoned and taken for taxes

at some time since they were split out of the original parcel. Forty six percent of them are now owned by oystermen. (See Table 3).

DEVELOPMENT OF OWNERSHIP BLOCKS

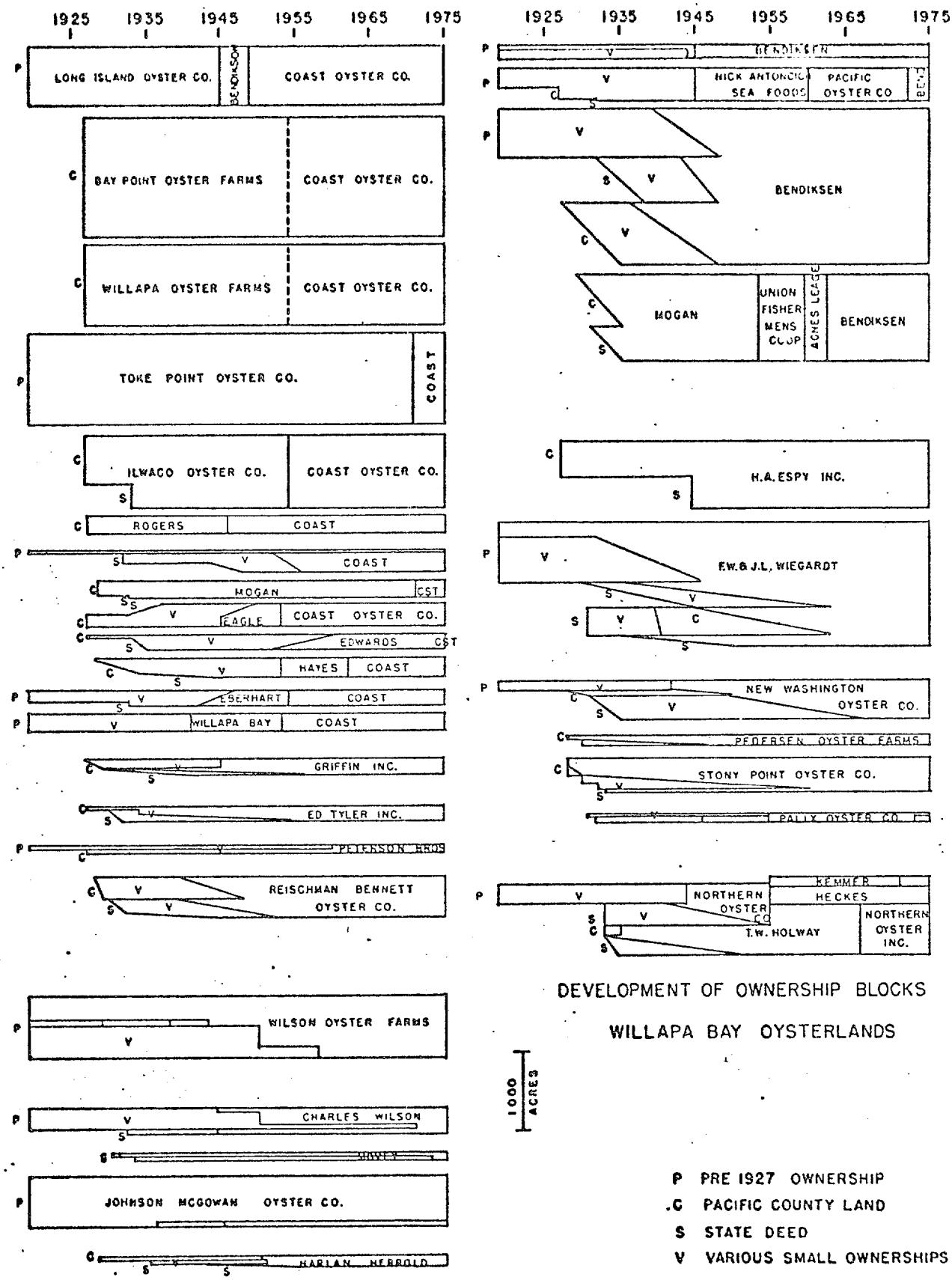
In 1927 only 9350 acres of oysterland remained in private ownership of the 16,200 acres which had been deeded by the state. The remainder was in Pacific County ownership as noted before. Three thousand two hundred (3,200) acres of this was held by the larger oyster companies of that time. The remainder was in parcels of less than 200 acres. An unknown amount of potential oysterland existed in the states tidelands.

New ventures in the industry or expansion of old ones were dependent on purchase of county land, new deeds in the state tidelands or purchase of previously existing oysterland still in private ownership, for land on which to farm. Two major blocks of land ownership were established at this time other than that put together by Mogan. Ilwaco Oyster Company was formed by acquiring 500 acres of county land from the county and sources other than Mogan and an additional 100 acres of county land from Mogan. Several years later 300 acres more were acquired through the purchase of subdivision tracts to produce a block of land of 900 acres. Espy Inc. which had disposed of its earlier holdings, developed a new block of land ownership by the acquisition of 520 acres of county land from the county and much later (1944) added 430 acres of state tidelands to form a block of 950 acres. Smaller blocks were put together by Stony Point Oyster Company and Pedersen Oyster Farms through the acquisition of county land directly and some new state tidelands. By 1935 the available county land was thus tied up and much of the potential state tideland had been

TABLE 3

OWNERSHIP OF SUBDIVISION PLOTS

AREA	TOTAL ACREAGE SUBDIVIDED	NUMBER OF PLOTS	NUMBER OF COMMERCIAL OWNERS	NUMBER OWNED BY COUNTY (now or in past)	% COMMERCIAL	% COUNTY
A	334.32	47	29	18	62	38
B	1968.14	479	128	186	27	39
C	1093.70	109	72	54	66	50
D	660.37	19	15	1	79	5
E	1794.96	147	128	22	87	15
TOTALS	5851.49	801	372	281	46	35



DEVELOPMENT OF OWNERSHIP BLOCKS

WILLAPA BAY OYSTERLANDS

FIGURE 4

deeded. Land was then only available through Mogan, other subdividers, owners of subdivision tracts or individual owners of pre-1927 oysterland still in private hands.

Between 1935 and 1945 a number of new small oyster companies were formed with ownerships of 200-500 acres of land and the previously existing companies increased their holdings both primarily by the acquisition of individual plots from subdivisions and new state deeds. The amount of county land increased during this period as absentee owners lost interest and the poor character of some of the newly deeds state land became apparent. Two companies acquired holdings exceeding 2000 acres by the combination of some previously existing large blocks, and the combination of a number of small individual tracts and small ownerships.

By 1955 most of the small companies formed between 1935 and 1945 had doubled their holding in land through the acquisition of subdivision tracts. The large companies grew through the absorbtion of several smaller companies holdings. Two of these had holdings (blocks developed by Mogan) of over 1000 acres. In the next twenty years the large companies grew more in their land holdings by the same means. The smaller companies increased their holdings very little. (See Figure 4 and Table 4).

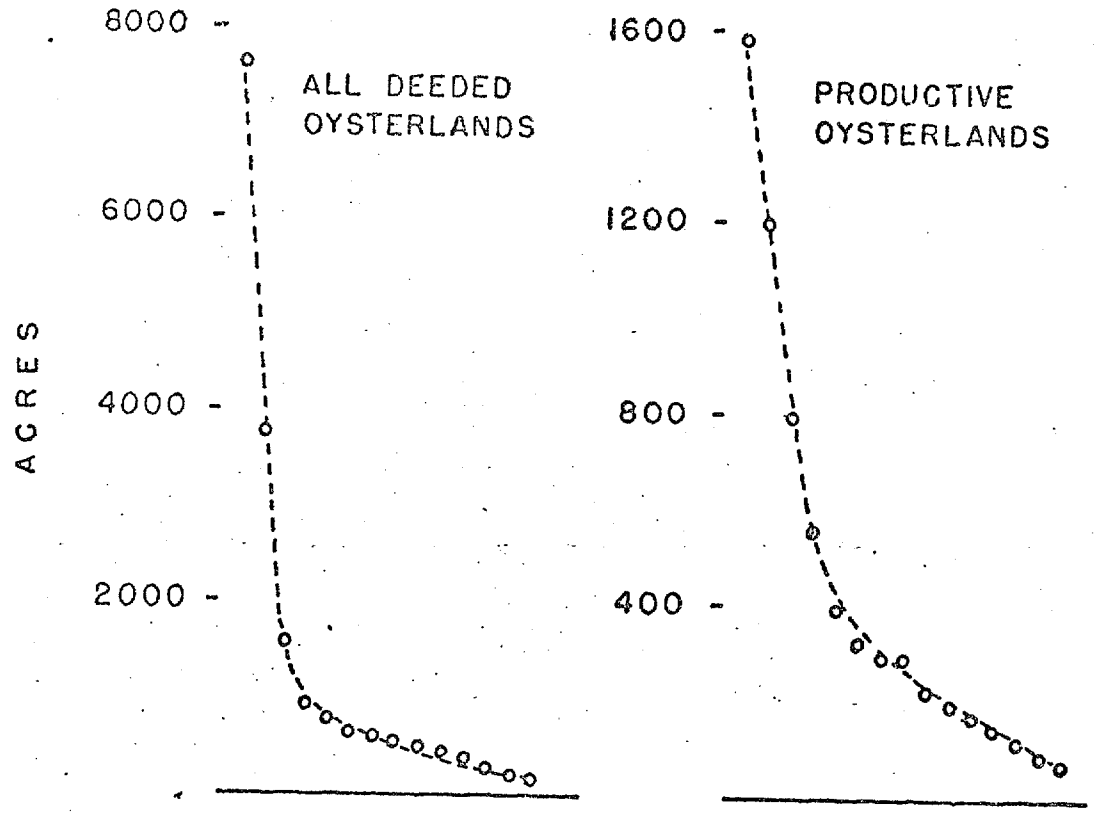
TABLE 4

DISTRIBUTION OF OYSTERLANDS - OWNERSHIP PATTERNS

OWNERSHIP BLOCKS	1927	1935	1945	1955	1975
2000 Acres +	0	0	6100	7725	11350
1000 +	1150	4850	2350	3750	1600
500 +	1450	3350	2500	3850	4005
200 +	600	850	2910	1950	1415
County	6900	1000	2800	1600	1300
Small Ownerships	5900	12950	9090	7125	6330
TOTAL	16000	23000	25750	26000	26000

Forty six percent of the land was owned by two companies in 1975. Lease agreements on other blocks of land provided them with control of over 50% of the available land. (See Figure 5).

The pattern of oysterland ownership from 1927 on was one of larger holdings. All farms increased in size in response to the capital requirements of more mechanized operations. It appears that 300-500 acres, depending on the quality of the land, is necessary to carry on a full operation of see-catching through processing. Smaller operations are unable to support an opening house and operations of 200 acres or less generally cannot support major items of equipment, such as dredges, docks, trucks and hoists unless they have been previously amortized.



DIVERSITY OF BLOCK SIZE

FIGURE 5

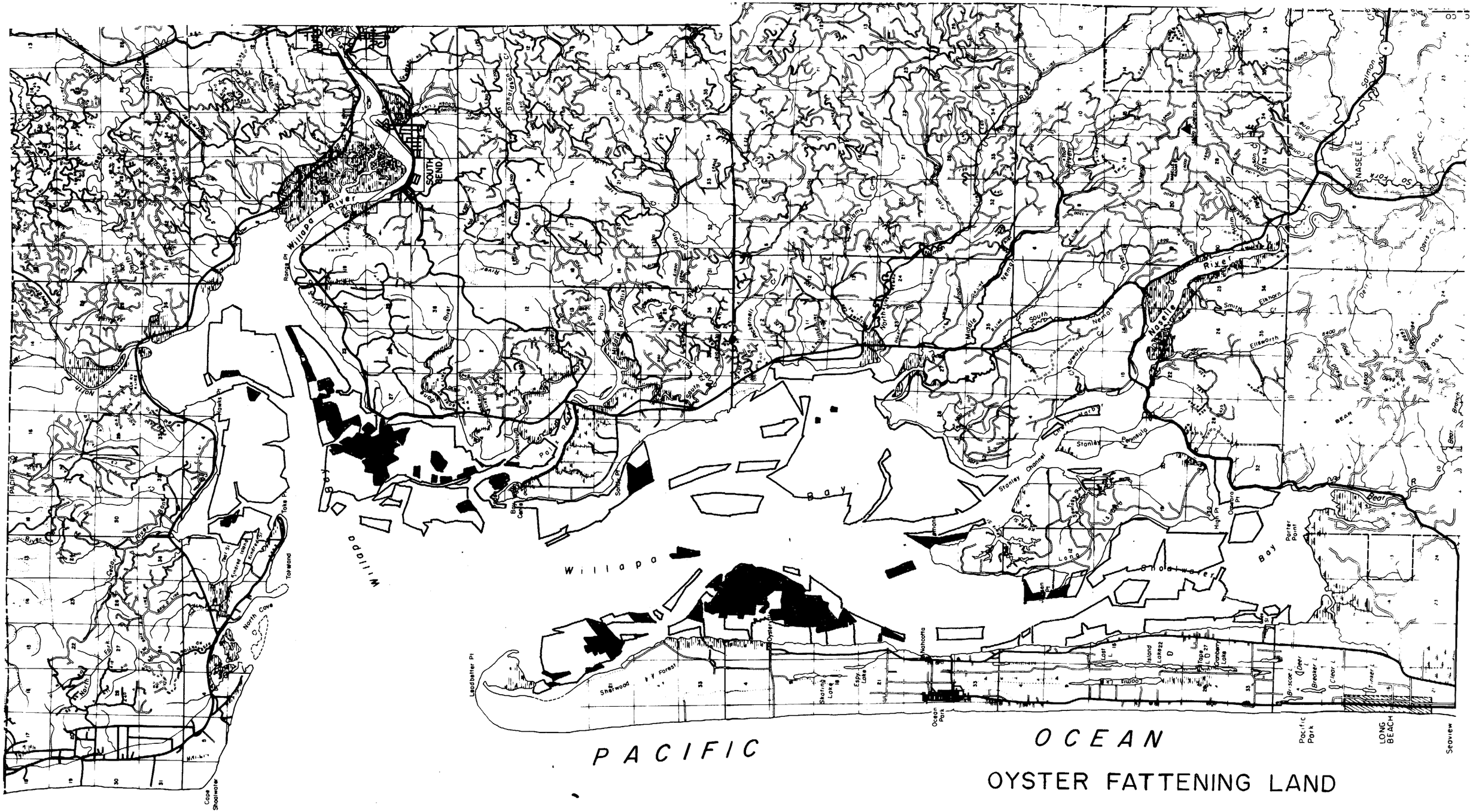
It will be developed later that not all the land in the ownership blocks outlined above is suitable for the culture of oysters. They do not then provide a basis for estimates of productive potential of any of the blocks developed. Figure 5 indicates the diversity of land block ownership when only the productive land is considered. A similar dominance is present but the total acreages involved are considerable less.

USEABLE LAND

Oysterland like upland farmland varies in its ability to produce a marketable oyster. Some lands catch seed more frequently than others, some provide conditions for good growth but the oysters do not fatten there and others provide the fattened marketable oyster. Lands of these varying qualities are not necessarily mutually exclusive, that is some lands will meet all three requirements. More commonly, however, each of these various characteristics are typical of rather broad areas. For this reason oysters are transplanted one or more times as they grow, from seed ground or racks to growing ground to fattening ground. Fattening ground will ordinarily provide both good growth and fattening requirements but it is at a premium so that it is not practical to commit good fattening ground to growing when areas which will not fatten or take an extended period to fatten an oyster are more available. A grower should then have a balance of these varying types of ground in his ownership in order to produce at the highest level. A grower with 200 acres of ground well balanced in these characteristics may be able to produce more gallonage than another grower with twice that amount but without balance. Since oysters derive their food from filtering water passing over the bed the varying characteristics referred to must reflect something of the local currents and the way then distribute nutrients, fresh water and ocean water in the bay. It also reflects the relative elevation of the bed in the tidal area, a factor of time in the water. Changes in the features which control current, nutrient generation, elevation of the beds and their texture effect the value of tidelands for the culture of shellfish. Texture of the beds is another important factor which may change due to exterior activities and also effect the usefulness of oysterlands.

The biologic and hydrologic factors referred to above are not easily measured and judged for any given plot of oysterland. The suitability of lands for the cultivation of oysters can only be determined within rather broad limits when only measureable physical characteristics of the ground and overlying waters are employed. The oysters themselves still supply the best indicator of the growing characteristics of a given plot.

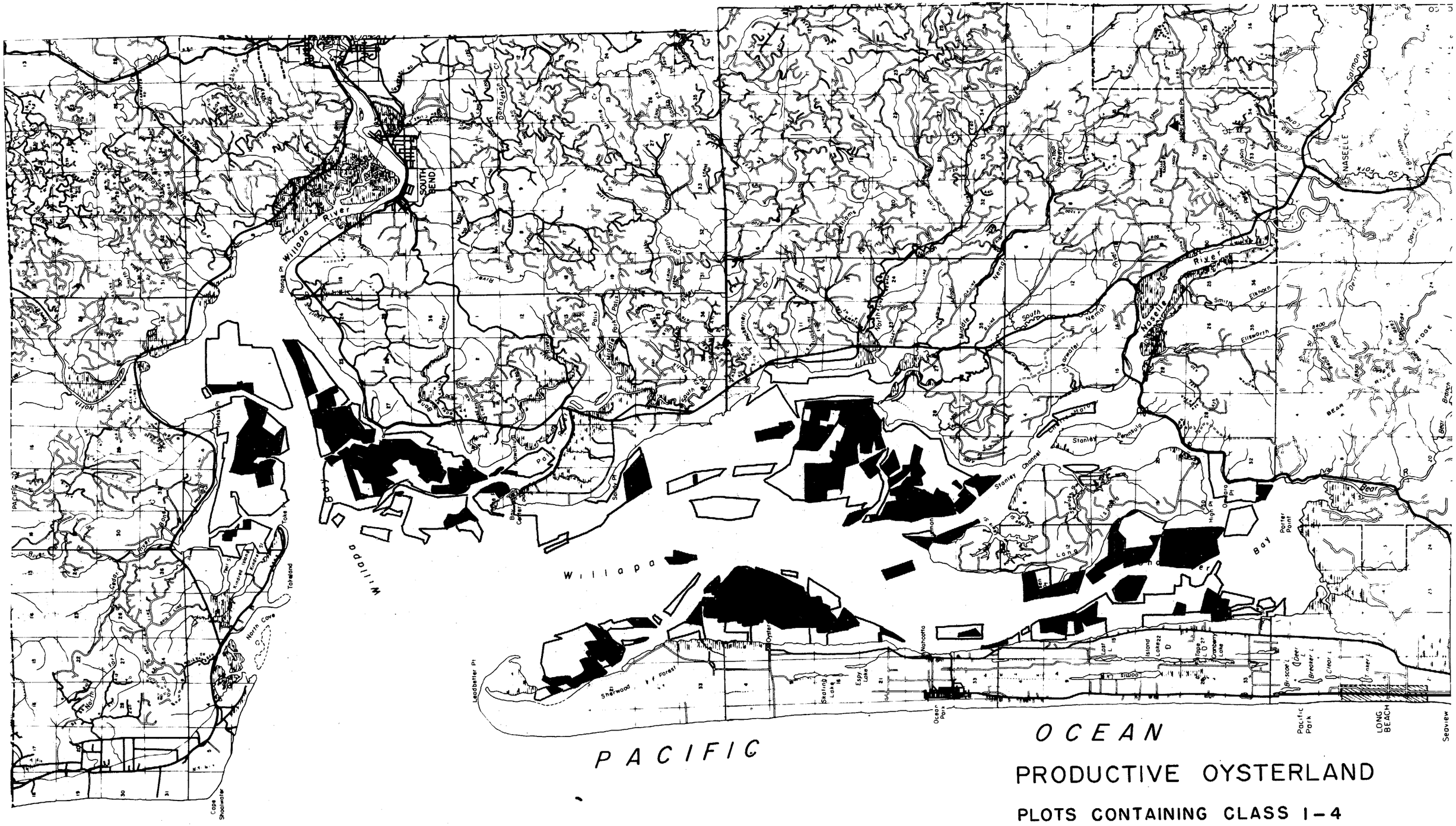
The oyster lands claimed and deeded between 1895 and 1927 were those which had been previously used for the culture of oysters and had proven their value for this purpose. They would be expected to be the best of the available lands. The plots claimed were not contiguous with one another although they were grouped together within limited areas. High spots in the tidelands, sloughs, soft ground, ground on which oysters could not be held against the current, etc. were often left unclaimed so that adjacent plots did not always have common boundary lines. As



OYSTER FATTENING LAND

PLOTS CONTAINING CLASS 1 OR 2 OYSTERLAND

FIGURE 6



PRODUCTIVE OYSTERLAND

PLOTS CONTAINING CLASS I–4 OYSTERLAND

FIGURE 7

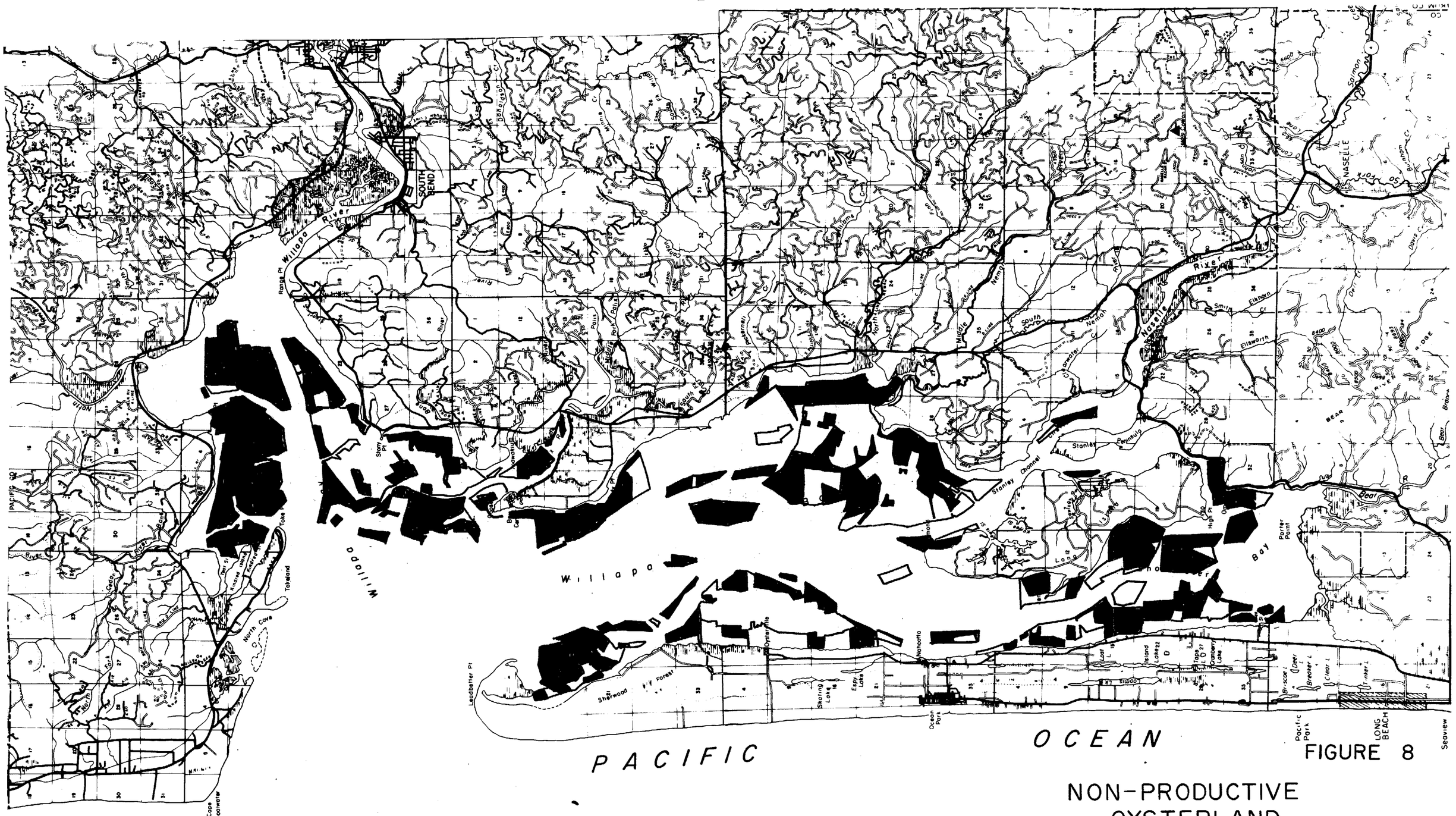


FIGURE 8

NON-PRODUCTIVE OYSTERLAND

PLOTS WITH 50% OR MORE CLASS 5 LAND

described earlier nearly half of this ground was allowed to go for taxes prior to 1927, however the reason was not always a reflection of the character of the ground but a function of the condition of the industry. County owned land acquired after 1927 was thus this preferred ground. State deeds land after 1927 are lands peripheral to the original culture areas or the sloughs and other spaces between the earlier claims. It would be expected then that this would be for the most part poorer land. Limitations to this approach are the facts that the characteristics of the land are not static and that the ground requirements for the Japanese oyster are probably somewhat different than those for the Native oyster which formed the basis for the original choice of land in the bay (See Figure 2).

The county assessor appraises oysterlands for tax purposes. Lands are classed on five numbered categories, on through five. The assignment of lands to a class has been done by oystermen working with the assessor. A given plot may include several classes oysterland. The classes are based on the ability of the land to produce oysters. The first and second classes include those lands which will produce a marketable oyster in a reasonable length of time. Classes three and four are lands which take an extended period to produce a marketable oyster but may produce good growth over shorter periods of time. Class five is the poorest land which has little or no value for oyster culture. County land is not appraised so that oysterland in county ownership at the time of appraisal does not appear in the figures for acreage. Presumably it can all be considered as the equivalent of class five land.

Table 5 summarizes the distribution of oysterland of Willapa Bay within the various classes. Ten percent of the total deeded oysterland is found in Class I or II, thirty percent of the land is found in Class III or IV and sixty percent of the land is in the poorest class (Class V). The distribution of the various classes of land within different areas of the Bay is disproportionate. Ninety percent of the Class I and II land is in two areas, "B" and "E". The figures also indicate that more than one half the deeded oysterland in the bay is of little or no value for the cultivation of oysters.

The total useable land, Classes I through IV, is 10,076 acres using the classification system described above. This total represents a varying proportion of the total deeded lands in each of the areas of the bay.

Figures 6, 7 and 8 illustrate the distribution of the different types of oysterlands in Willapa Bay. Figure 6 indicates plots which have within their boundaries Class I or Class II land, fattening ground. Figure 7 shows the distribution of plots which contain Class I through Class IV land. Figure 8 illustrates the non-productive lands which include plots which have fifty percent or more Class V land or which are in county ownership. Since a plot of land may include several classes of land there will be some overlap. The purpose is to illustrate the distribution of the best, poorest, and productive (useable) oysterlands.

TABLE 5

DISTRIBUTION OF CLASSES OF OYSTERLAND

Area	Class I & II	Class III & IV	Class I - IV	Class V	Total	Percent I - IV
A	55	183	238	3659	3897	7
B	915	1008	1923	3741	5664	34
C	171	3802	3973	3400	7373	54
D	58	2112	2170	2590	4760	46
E	1291	481	1772	2094	3866	46
Totals	2490	7586	10076	15484	25560	
Percent	10	30	40	60		

Other means of estimating useable oysterland in Willapa Bay may be used. Tidelands which do not provide the combination of conditions which produce oysters are not likely to be retained by the oysterman. The practice has been to simply let the beds go for taxes. Examination of tax foreclosures should provide some insight into the distribution of useable oysterland within the tidelands of Willapa Bay. Two factors limit the value of such an approach. The larger land holders have never allowed land to go for taxes, irespective of its oyster culture value and a number of absentee owners of subdivision tracts have maintained their ownership even though the land has long since proved to be of no value for the culture of oysters. Allowance for these two factors can be introduced and some estimate of the amount of useable oyster ground estimated.

In applying the approach outlined above, the lands held by large owners which have not allowed land to go for taxes and thus represent a significant block of land not responsive to the approach to be applied were eliminated from consideration. Their retention in the figures would mask the results. These large holdings comprise major portions of areas "A", "D" and "E" and thus do not leave a large enough sample in these areas to apply the technique there. Table 6 lists the acreages removed from consideration in areas "B" and "C" segregated into Old (land deeded before 1929) and New (land deeded after 1929) and the proportion these acreages are to the total of the area deeded.

The land rush sales did not drop back to norman level until about 1940 (See Figure 3). It is felt that only after this date was the value of land for oyster culture the major factor in whether it was retained or allowed to go for taxes. The abstracts which had been prepared for each plot of oysterland were then examined (except for those indicated above) to identify those which had at some time since 1940 been in county ownership. Data for old oyster ground (pre 1929) was kept separate from that of new ground (post 1929). The totals for each area, segregated for old and new land were then computed. This figure was then converted to a percentage of the acreage considered, maintaining the segregation of areas of old and new land. At

OYSTER LAND CLASSIFICATION

CLASS I — Oyster production or growing land is used in producing marketable oysters. Generally located where there is good circulation of water and plenty of feed available. This is the very best land in the bay. The seed and marginal land will be generally located between the production land and shore line.

CLASS II — Oyster production land or growing land has the same general characteristic as class one. The biggest difference being in the amount of food available, which limits the production of marketable oysters.

CLASS III — Oyster seed land is used for the catching, holding, or development of oysters. Generally speaking the area is located between production land and marginal land. The available food supply and the amount of time, it is not covered by water generally, determines how good it is.

CLASS IV — Oyster seed land is used for the same purpose as class three, however, it generally won't support very much of a seed crop as it is very closely related to the marginal land. It has a very poor supply of food.

CLASS V — Oyster marginal land is located between the shore line and the seed area, however, it may be found any place in the seed or production area. It is of little value other than as for protection for the other class beds.

from Eberhardt report to State Tax Commission

TABLE 6

ESTIMATED USEABLE OYSTERLAND

OLD OYSTERLAND						
AREA	TOTAL ACREAGE	ACREAGE HELD IN LARGE OWNERSHIPS	SAMPLE ACREAGE	COUNTY OWNERSHIPS AFTER 1940	SAMPLE BALANCE	% USEABLE
B	3140.7	1386.3	1754.4	160.6	1593.8	91%
C	5193.7	2951.6	2242.1	290.0	1952.1	87%
NEW OYSTERLAND						
B	2786.8	464.4	2322.4	1591.1	731.3	31%
C	2310.9	281.8	2029.1	733.6	1295.5	64%

ESTIMATED USEABLE LAND				
AREA	TOTAL ACREAGE	SAMPLE %	TOTAL USEABLE	TOTAL FOR AREA
B OLD	3140.7	91%	2858.0	
B NEW	2986.8	31%	863.9	3721.9
C OLD	5193.7	87%	4518.5	
C NEW	2310.9	64%	1479.0	5997.5

this point the acreages of the blocks of land previously eliminated were added back into the totals and the percentage arrived at for the sample was applied to the totals for each area. This then provided an estimate of the total land held in low enough esteem to be abandoned. The totals indicate that a much smaller percentage of old land has been abandoned at some time in the past than new.

It also indicates that about 28% more land has been retained private ownership than is included in the total of Class I-IV land. Extrapolated to include all the oysterland it would indicate about 13, 370 acres of useable land.

Another method for determining the amount of useable oysterland is to examine airphotos and measure the areas which are in use. Of the available airphotos only those of the "B" area for 1974 are suitable for this purpose due to the tide level at the time the photos were made. In analyzing the photos, it was realized that useable land is not in continuous use so that general areas of use were deliniated to allow for this rather than to meausre just those portions of plots in use in the summer of 1974. The photos used were at a scale of 1" = 1000'. By this method 23[illegible] acres were condisered to be in use in the "B" area. This represents 39% of the deeded land in the "B" area. Using the Class of land figures of the assessor it was determined above that 34% of the deeded land of the "B" area was included in Class I through IV. The photo results are drawn on the map, Figure 9

which illustrated higher class land distribution in the "B" area. They agree rather closely. It appears that the Class designations may provide a reasonable estimate of the useable deeded oysterland in the bay, about 10,000 acres. It should be noted that the estimate reached here assumes the culture methods employed today, that is, bed culture.

It is unlikely that there is any significant area of tidelands suitable for the culture of oysters in Willapa Bay, outside the reserves, which has not already been recognized and deeded, or leased. The reserves contain a little less than 10,000 acres however much of this is subtidal land. Since it has not been intensively farmed it is difficult to estimate useable tideland within the reserves. It probably totals less than 2000 acres. It therefore appears that the available land resource for the bottom culture of shellfish in Willapa Bay is limited to about 12,000 acres.

IDENTIFICATION AND DISTRIBUTION OF UNUSEABLE OYSTERLANDS

The estimates made above indicate that over 15,000 acres of deeded oysterland in Willapa Bay are marginal for growing oysters. Because of the speculative nature of the dealings in oysterland in the 1930's the question arises as to how much of this acreage was ever suitable for oyster culture. More importantly, it is desireable to identify areas which were once productive and have subsequently become unuseable and to determine what the nature of the change has been that brought about the apparent failure and when these changes occurred.

Examination of ownership records indicates which deeded oysterlands were probably never suitable for oyster culture. These lands may simply have been a poor choice of land or may have been acquired for speculation through subdivision with no concern for its ability to support oyster growth. County foreclosure occurs at a minimum of seven years after the owner ceases to pay taxes. Foreclosure seven years after the deed date on a plot of oyster land indicates that the land was found to be of little value for culture and abandoned or that subdivisions of it were not saleable. Frequent changes of ownership, numerous plots, if subdivided, in county ownership at some time and the lack of ownership by oystermen implies that the plots of a subdivision were probably never oysterland. They are all currently classed as marginal class V land.

Using the above criteria the ownership histories of each plot of land in Willapa Bay were examined. The following table lists the acreages by area which were probably never suitable for oysterland:

AREA	NEVER OYSTERLAND
A	941
B	1180
C	686
D	74
E	1078
TOTAL	3959

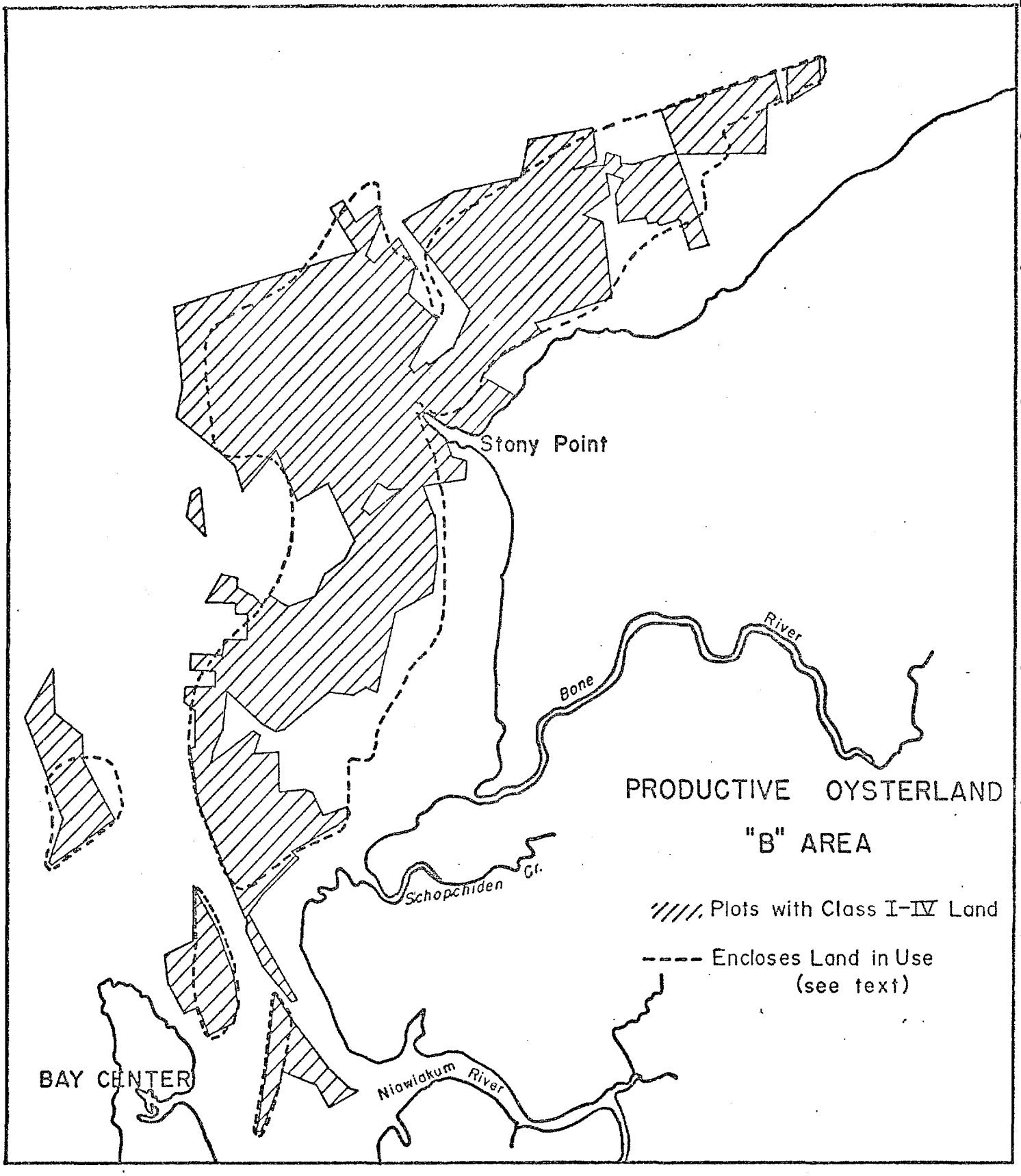
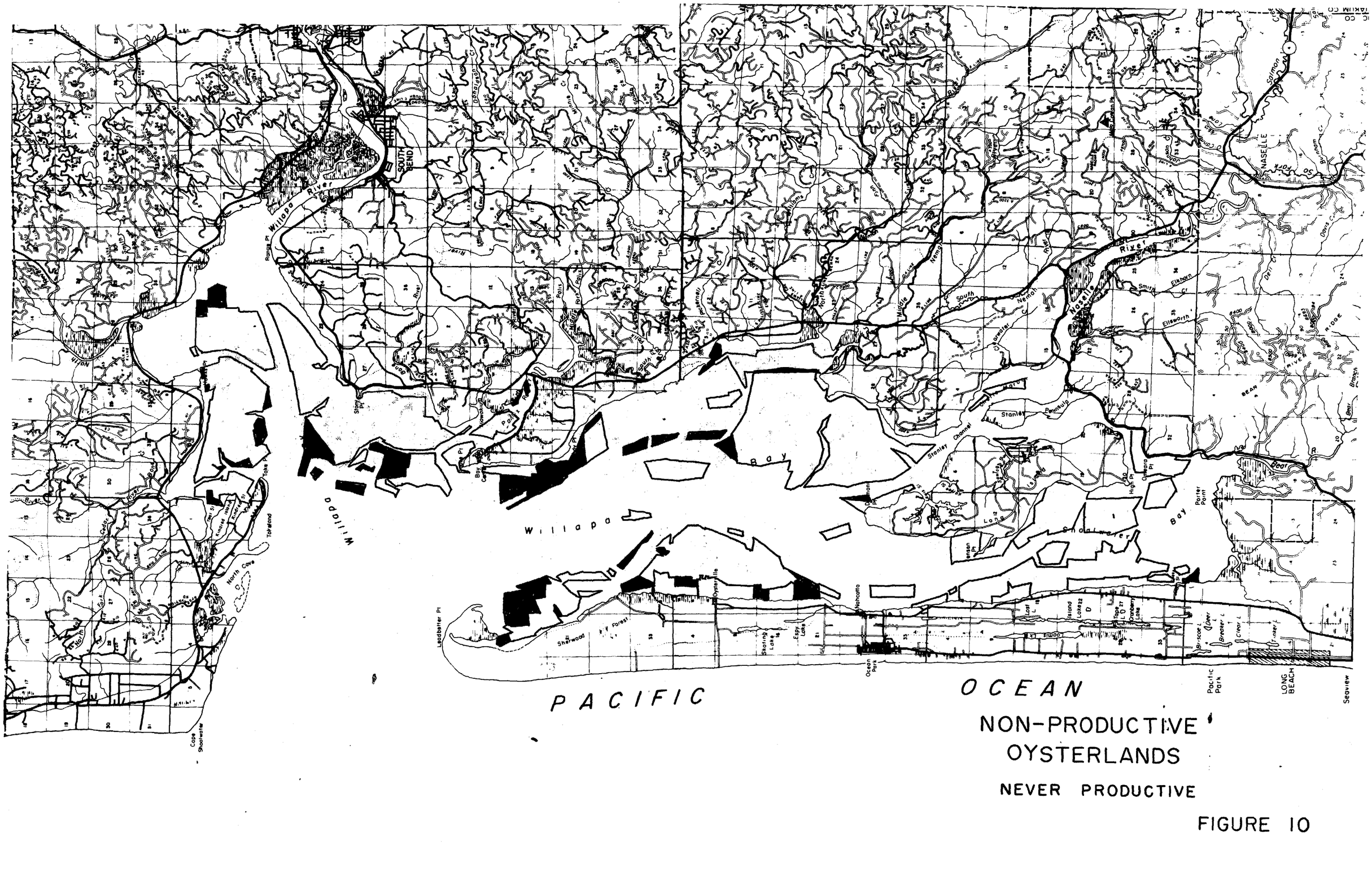

Stony Point
Bone River
PRODUCTIVE OYSTERLAND
"B" AREA
Schopchiden Cr.
//// Plots with Class I-IV Land
---- Encloses Land in Use
(see text)
BAY CENTER
Niawiakum River

FIGURE 9



NON-PRODUCTIVE
OYSTERLANDS

NEVER PRODUCTIVE

FIGURE 10

TABLE 7

. OYSTERLAND CLASS CHANGES AREAS A AND B 1959-1970

Area & Year	Classes of Oysterland					
	I	II	Total I + II	III	IV	Total I - IV
East "A" 1959	63	159	222	20	78	320
East "A" 1970	20	0	20	33	10	63
Difference	-43	-159	-202	+13	-68	-257
West "A" 1959	330	226	556	162	104	822
West "A" 1970	0	35	35	131	9	175
Difference	-330	-191	-521	-31	-95	-647
East "B" 1959	226	170	396	223	138	757
East "B" 1970	215	45	260	165	128	553
Difference	-11	-125	-136	-58	-10	-204
Central "B" 1959	817	408	1225	566	448	2239
Central "B" 1970	447	208	655	475	226	1356
Difference	-370	-200	-570	-91	-222	-883
South "B" 1959	5	24	29	0	55	84
South "B" 1970	0	0	0	0	15	15
Difference	-5	-24	-29	0	-40	-69
Total "A" Area Differences	-373	-350	-723	-18	-163	-904
Total "B" Area Differences	-386	-349	-735	-149	-272	-1156

Area designations follow production areas used in production section.

The location of these lands is illustrated in Figure 10.

Of the oysterlands in Willapa Bay which are marginal Class V land, nearly four thousand acres were probably never used or suitable for the cultivation of oysters. If we eliminate these lands from further consideration it appears that about one half of the remainind deeded oysterlands in Willapa Bay are presently productive and the other half are non-productive. These categories each represent between ten and eleven thousand acres. Undoubtedly most of these non-productive beds which are now Class V lands were once useful oyster ground. The deeded oysterlands were classified in 1959 for all areas. These classifications were reviewed in 1970 and significant class changes were required in areas "A" and "B" in the northern portion of Willapa Bay. A comparison of available productive oyster beds is thus possible on the basis of these two classifications for the Northern part of the bay. Table 7 contains these comparisons. They indicate that there was nine hundred and four acres less of productive oysterland in the "A" area in 1970 than in 1959 and eleven hundred fifty six acres less in the "B" area. The majority of the lost productive ground in both areas was in fattening land. This loss represents 79% of the available productive oysterland in the "A" area between 1959 and 1970 and 38% loss in the "B" area.

A major problem to the oyster industry in Willapa Bay is the loss of productivity of a large portion of deeded tidelands. The primary physical changes in oyster beds have been those brought about by the deposition of large amounts of sediment. The result has been that the level of beds was elevated too high to support good growth, or the texture of the beds has been changed so that oysters could not be grown there. Other changes are also evident. Some areas have become overwhelmed by burrowing organisms which alter the texture of the surface and again may reflect a secondary effect of sedimentation. Still other areas do not receive the nutrients at a level previously available suggesting hydrologic changes or productivity changes in the bay. An attempt to relate these changes to other factors will be made later in this study.

TABLE 8

WASHINGTON OYSTER PRODUCTION BY AREA IN NUMBER OF GALLONS

Year	Puget Sound	Grays Harbor	Willapa Bay	Washington Total
1935	146,709	6,000	473,257	662,526
1936	108,800	6,000	605,920	754,949
1937	72,080	5,150	804,217	911,447
1938	102,171	10,150	845,200	987,384
1939	135,109	10,150	802,217	974,482
1940	127,428	42,950	934,366	1,130,195
1941	165,337	19,500	1,131,406	1,345,752
1942	148,308	9,500	1,021,051	1,205,253
1943	95,497	8,250	673,749	796,650
1944	169,920	16,800	740,617	945,363
1945	248,331	17,800	815,017	1,098,417
1946	260,720	19,400	1,234,182	1,533,647
1947	229,661	15,800	968,629	1,230,774
1948	246,450	38,000	799,429	1,101,533
1949	261,356	82,600	528,560	895,716
1950	229,467	83,100	497,234	825,669
1951	227,571	58,068	582,491	880,427
1952	268,258	50,171	712,251	1,044,417
1953	275,752	67,874	752,983	1,110,049
1954	408,167	92,744	683,431	1,193,654
1955	382,936	119,633	644,598	1,154,742
1956	384,481	121,526	702,814	1,212,322
1957	380,383	97,600	660,387	1,141,120
1958	396,589	70,684	621,743	1,093,188
1959	461,310	113,180	574,305	1,154,165
1960	424,096	97,652	528,990	1,056,807
1961	339,590	76,015	574,088	994,816
1962	397,387	72,036	550,197	1,023,995
1963	394,387	62,440	487,362	948,452
1964	419,223	67,777	452,830	944,290
1965	416,813	84,774	396,396	903,788
1966	297,131	70,557	400,616	773,743
1967	348,575	72,696	346,491	773,380
1968	287,011	54,044	387,991	735,023
1969	252,227	44,859	354,378	657,450
1970	302,704	40,905	400,360	750,027
1971	302,257	74,821	400,644	783,593
1972	355,627	64,054	415,678	838,769
1973	282,041	39,933	324,310	648,447
1974	182,126	29,431	245,355	459,296

Data from WDF Reports

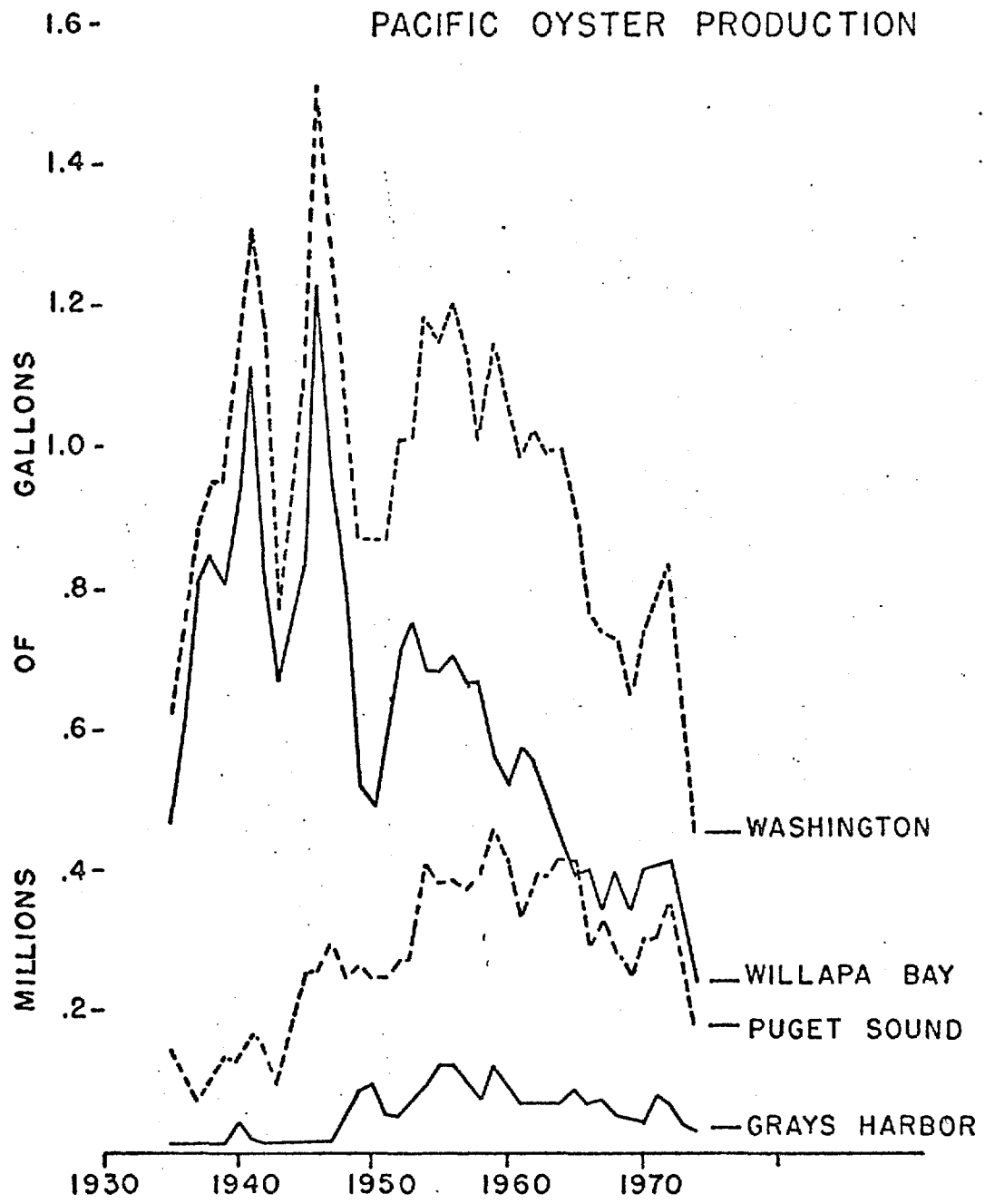

PACIFIC OYSTER PRODUCTION
MILLIONS OF GALLONS
1.6
1.4
1.2
1.0
.8
.6
.4
.2
1930
1940
1950
1960
1970
WASHINGTON
WILLAPA BAY
PUGET SOUND
GRAYS HARBOR

FIGURE 11

PACIFIC OYSTER PRODUCTION

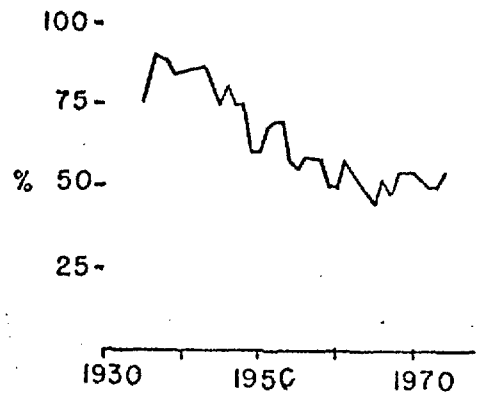
Pacific oyster production increased rapidly after the introduction of the new oyster into Willapa Bay. By the beginning of World War II it had reached a peak of 1,130,000 gallons per year (1941). During the war production dropped to a low of 674,000 gallons (1943) but again increased to a new high in 1946 of 1,234,000 gallons. Production fell off rapidly in the next several years to a low of 497,000 gallons in 1950. For the next three years production increased gradually to 753,000 gallons. After 1953 production steadily declined to a level of about 400,000 gallons in 1965 and varied slightly about this level until 1972. Production dropped rapidly to a new low of 245,000 gallons in 1974.

Total pacific oyster production for the state closely paralleled that of Willapa Bay until about 1969. A small three year increase in the state total after 1969 did not develop in the Willapa Bay production. Production in Puget Sound has had a somewhat different history than that of Willapa Bay. Although the same dips in production occured there as in Willapa Bay they were proportionately much smaller. The production in Puget Sound generally increased after 1937 until it reached a plateau in 1954. It maintained this level, about 400,000 gallons per year, until 1965 then dropped off to its present low level. (See Figure 11).

In 1935 Willapa Bay produced 75% of the pacific oysters in Washington. By 1937 this proportion had increased 90%. As Puget Sound pacific oyster production increased and Willapa Bay production decreased the proportion of state production from Willapa Bay dropped to 50% by 1960. It has varied about a level of a little over 50% since then. (See Figure 12 and Table 8).

U.S. production of all species of oysters reached a high in the late 1800's of nearly 200 million pounds. With the encroachment of cities into oyster growing areas of the East and the accompanying pollution, there was a loss of production from many areas. U.S. production drastically dropped to a level of about 80 million pounds about the time pacific oysters were first harvested in Washington. This new product soon accounted for ten to fifteen percent of the national production. Even though Washington production has decreased the proportion that it makes up of the total U.S. production has remained at about the same level, due to more recent losses of production from disease in eastern oysters. (See Figure 13).

Pacific oysters are intensively farmed on deeded tidelands. Production figures then are essentially harvest results and sales. Since it takes several years to grow a marketable oyster and oysters will live for many years it is possible for the oyster grower to withold his product from the market if he feels this is



% WASHINGTON HARVEST
FROM WILLAPA BAY

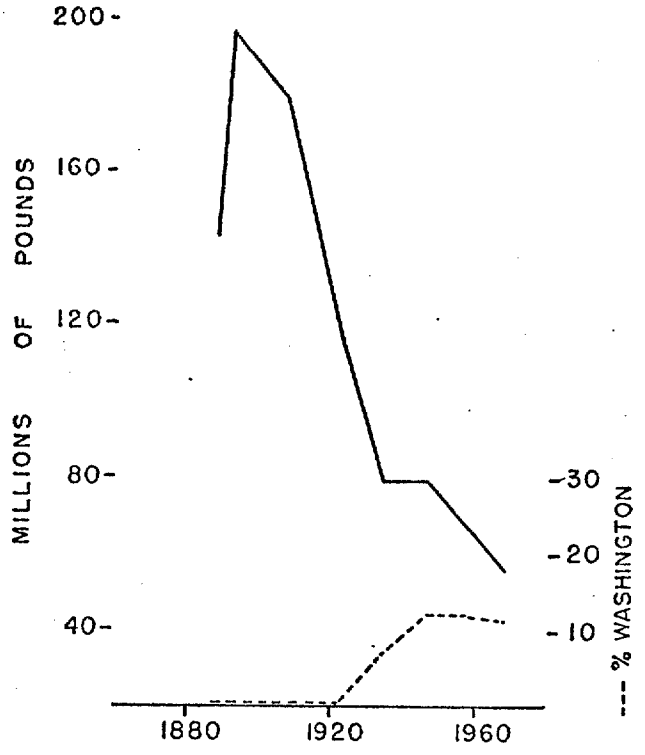
FIGURE 12

practical. Conversely he may find attractive market conditions but is not able to supply the oysters he could sell. His decisions on whether to obtain seed for future crops and the amount will depend on the cost of the seed, the cost of producing marketable oysters form that seed and his estimate of the market conditions when the oysters are ready to harvest several years later. The availability of land for the crop is another consideration. His considerations and decisions are thus similar to those of the upland farmer.

Production figures only indirectly reflect the ability of the bay to produce oysters. To the oysterman this ability appears as a cost factor. This is reflected in a statement in the Washington Department of Fisheries annual bullentin for 1944 "Many areas of Willapa Bay which once produced marketable oysters in 12 or 18 months now require four years to five the same yeild. The cost of oystering in these areas has been correspondingly increased. Other areas fail to produce an oyster of suitable fatness."

PRODUCTION CAPACITY

Production oyster land is segregated into fattening and growing lands. Growing lands are those which provide early development and growth. Fattening lands are those which provide the finishing off to a marketable oyster. Oysters are transferred from growing lands to fattening lands when they have reached a suitable size. Although transplants are largely of the same age class there is a wide variation in size of individuals present. Currently three to four years is required on the growing ground and one or two seasons required on the fattening ground. Three to four times as much growing ground as fattening is thus required in order to make the fullest use of the available ground. It is also evident that the maximum potential production from the bay is directly dependent on the amount of fattening ground available and the



U.S. OYSTER PRODUCTION
1880 – 1970
FIGURE 13

time required for fattening.

From the beginning of oyster culture in Willapa Bay it was recoginzed that the fattening grounds were largely limited to the northern part of the bay (Areas A, B and E) and that the grounds in the southern part of the Bay (Areas C and D) included primarily growing grounds. Growing grounds are also present in areas A, B and E of the northern portion of the bay. Growers usually have a combination of land in the southern portion of the bay (Areas C and D) from which they transfer oysters to lands in the A, B and E areas which they use for fattening. Since growing grounds are also present in the A, B and E areas the combination of types of land may be held entirely in one of these northerly areas and transfers are made over relatively short distances or sometimes not at all. This later practice is only possible for smaller operators.

Loss of fattening and growing characteristics of land thus reduces the potential productive capacity of the bay. It was determined earlier in this report that only about one half of the original oyster lands in Willapa Bay are now productive. It was also noted that major losses of productive land have occured in the "A" and "B" areas since 1959. Factors which control the productivity of oysterland are texture of the

ground, presence of pest or predators, height of the land in the intertidal zone and the availability of nutrients. Changes in these interrelated factors are reflected in the ability of the oysterland to grow oysters.

Texture of the ground, that is the coarseness of the particles which make up the ground and the compaction of these particles, reflects currents and sediment load carried by the currents. Deposition of fine sediment may bury oysters and either alter their shape or smother them. Coarse but loose texture ground, when subjected to currents, tends to draw oysters down into the sediment. Changes which bring about these results reduce the value of the ground for the culture of oysters. Major deposition of sediment on a bed may raise its elevation significantly. Since oysters only feed when they are immersed in water their relative position in the intertidal area directly effects their growth rate. Elevation of a bed thus reduces the productive capacity of the bed and often has made beds completely unproductive.

Even though there may be no physical change in an oyster bed its productive capacity may be reduced by changes in the availability of food. This effect may be a localized occurrence resulting from current changes or may be a broad effect due to changes in the capacity of the bay to generate food. The food of oysters consists of microscopic plants and detrital organic material. The microscopic plants are dependent on inorganic nutrients most of which are generated in the breakdown of plant and animal tissue. Some, such as silicate, originate from the freshwater drainage off the land. Digestion of dead plant and animal tissue occurs in the mud flats, marshes and ocean, primarily by bacteria. The microscopic plants have a generation time of from one to two days under ideal conditions of nutrient and light. They must then be in the estuary system several days in order to multiply and provide an adequate food source. The generation of useable food in the bay is thus a function of a number of complexly related factors, including fresh water inflow, frequency of exchange of the bay waters with those of the ocean, and characteristics of the shoreline and bottom of the bay including shallow vegetated areas.

Even though an area may meet all the requirements of oyster growth the development of pest, predators or mortalities from less direct vectors may make it useless as oyster culture ground. In Willapa Bay dense populations of ghost shrimp and large worms have removed some oyster ground from production. Native and introduced predators such as drills and crabs reduce the productivity of oysters. In some areas mortality of adult oysters has been a significant factor in the reduction of harvest.

All of the factors discussed above effecting the productivity of the land have combined to provide a production capacity today of about half that available in the early history of the pacific oyster industry in Willapa Bay. Production figures suggest that the early level was about 850,000 gallons and that of the last ten years about 450,000 gallons.

PRODUCTION AREAS

Production has been reported by sub-areas in the bay since 1956. These production areas have been derived by dividing the exisiting areas into two or three sub-areas as shown in Figure 14. Records of production from each of those areas with any significant production since 1956 are presented graphically in Figure 15 and Table 9. During this period each of the production areas of "E", Stackpole and Oysterville, have produced about 100,000 gallons per year with a major drop in production after 1971. In the Stony Point area of "B" production dropped over 200,000 gallons between 1956 and 1963 where it stayed at a level of about 60,000 gallons until 1967 when it began to increase again reaching just under 150,000 gallons by 1972. In the next two years it dropped down to a level of about 50,000 gallons. At the same time the Bruceport area produced an average of a little over 50,000 gallons per year. To the north in the Tokeland area of "A", production increased form 80,000 gallons in 1956 to 125,000 gallons in 1962-63 but in 1964 it dropped to a level of about 50,000 gallons and has remained there. Some production was realized from what are essentially growing areas. The south Nemah area of "C" produced at a level of 40,000 gallons until 1964, after that time production has been insignificant. A small variable production was realized out of the West Long Island area of "D".

The production drops in the 1970's apparently reflect market practices and do not represent production capacity changes. They will be discussed in a later section. The estimated 450,000 gallons production capacity for Willapa Bay appears to be distributed as follows:

"A" area	50,000
"B" area	200,000
"E" area	200,000

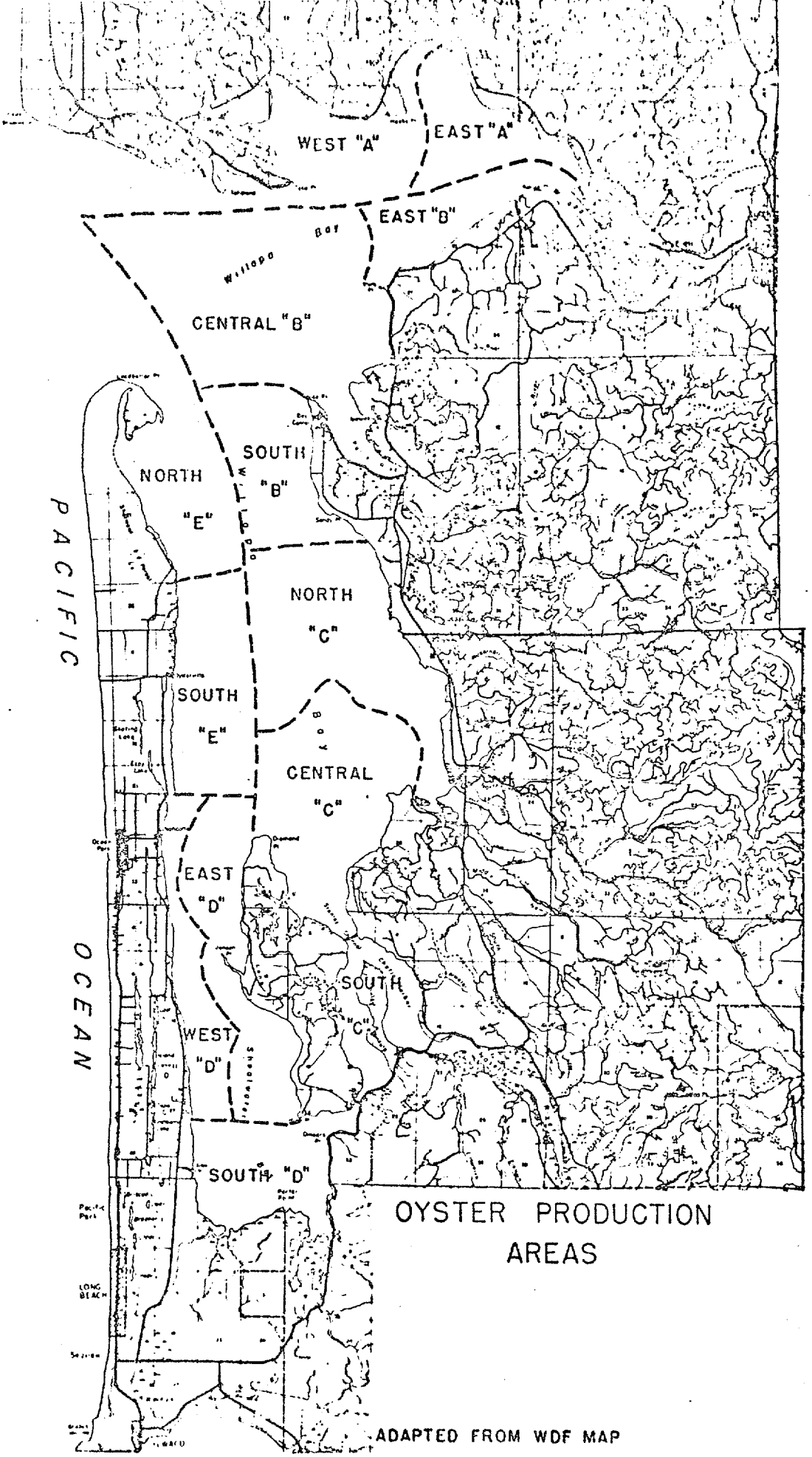

WEST "A"
EAST "A"
EAST "B"
Willapa Bay
CENTRAL "B"
NORTH "E"
SOUTH "B"
NORTH "C"
SOUTH "E"
CENTRAL "C"
EAST "D"
SOUTH "C"
WEST "D"
SOUTH "D"
PACIFIC OCEAN
OYSTER PRODUCTION AREAS
ADAPTED FROM WDF MAP

FIGURE 13

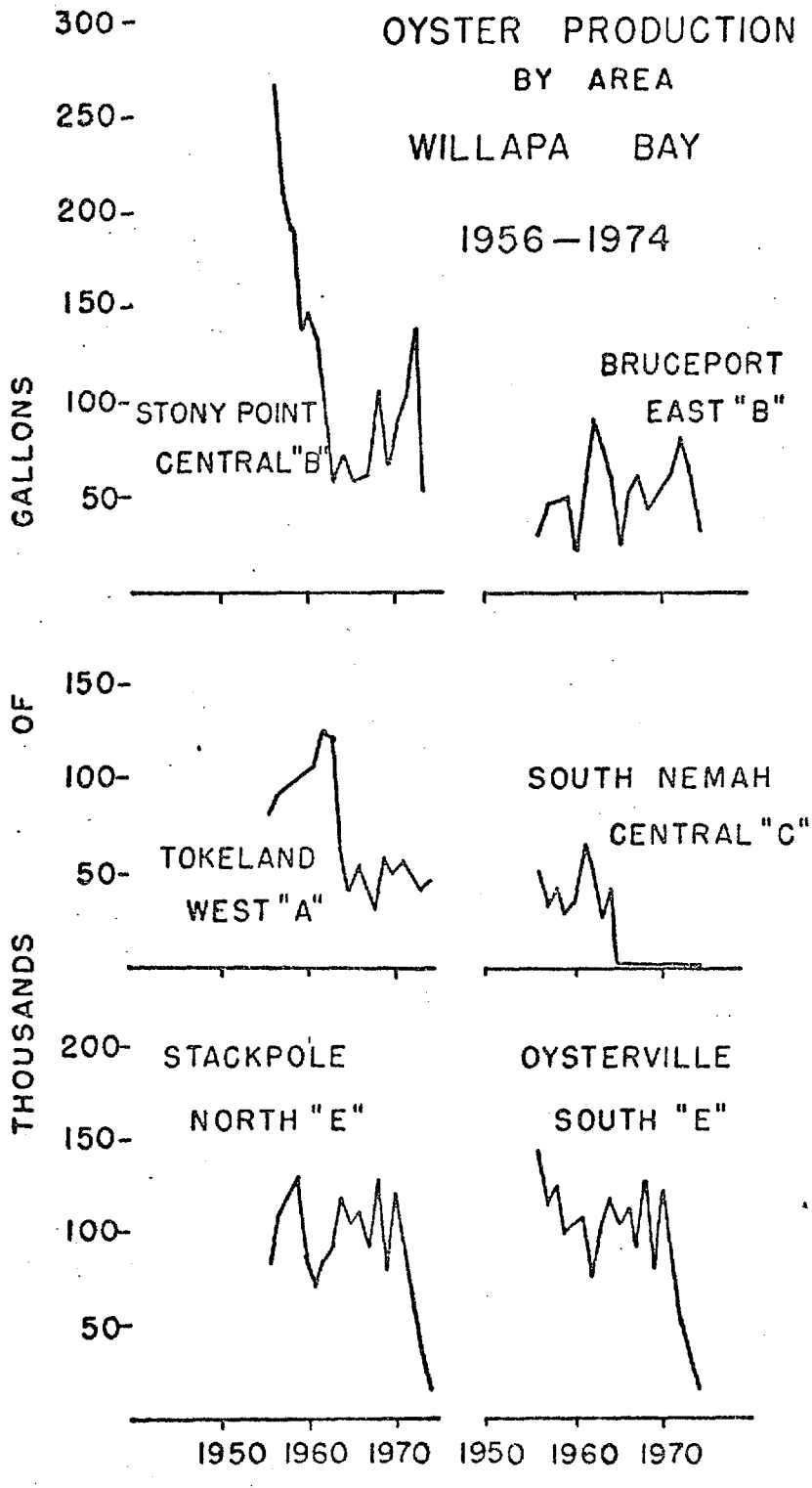

OYSTER PRODUCTION
BY AREA
WILLAPA BAY
1956—1974
GALLONS
OF
THOUSANDS
300-
250-
200-
150-
100-
50-
STONY POINT
CENTRAL "B"
BRUCEPORT
EAST "B"
TOKELAND
WEST "A"
SOUTH NEMAH
CENTRAL "C"
STACKPOLE
NORTH "E"
OYSTERVILLE
SOUTH "E"
1950 1960 1970
1950 1960 1970

FIGURE 15

TABLE 9

Pacific Oyster Production

Willapa Bay

By Production Areas

Year	North River	Tokeland	Bruce-port	Stony point	Goose Point	North Nemah	South Nemah	West Long Island	Stack-pole	Oyster-ville
1956	3972	80544	32026	266943	4563	10102	51622	26540	82910	143130
1957	19110	90979	46062	209915			34557	35526	110596	113642
1958		94541	45473	191028			42472	6815	118534	122464
1959	13437	96081	49193	136789	7803		29006	11808	129719	99820
1960		101859	22369	147759	12441		34772	20100	88815	100875
1961	7032	107421	63435	134631			65124	17857	70524	107492
1962	11378	125022	91292	107635	486		52140	1285	84924	76035
1963	412	122043	76464	59047			27192	5571	91676	104957
1964	4525	62961	62429	70323	1485		41546	20568	118736	70257
1965	3481	40522	25287	59285	445	4381	3070	20379	104682	134864
1966	8717	56641	53807	57381				29258	111507	83307
1967	613	44172	61229	62013			916	8831	91303	77414
1968		31640	45256	105935				2537	127040	79505
1969		58273	55180	67747			2561	4604	79752	66258
1970		50538	59761	90001			637	5234	119381	73981
1971		56869	63969	103429			6312	9587	82678	77800
1972		51669	81990	139817			1729	3370	50099	87004
1973		40462	57844	53891				15251	35417	121445
1974		46747	34059	49373	4157		3568	5	16639	90807

Unpublished data from Statistical Division WDF

OYSTER SEED

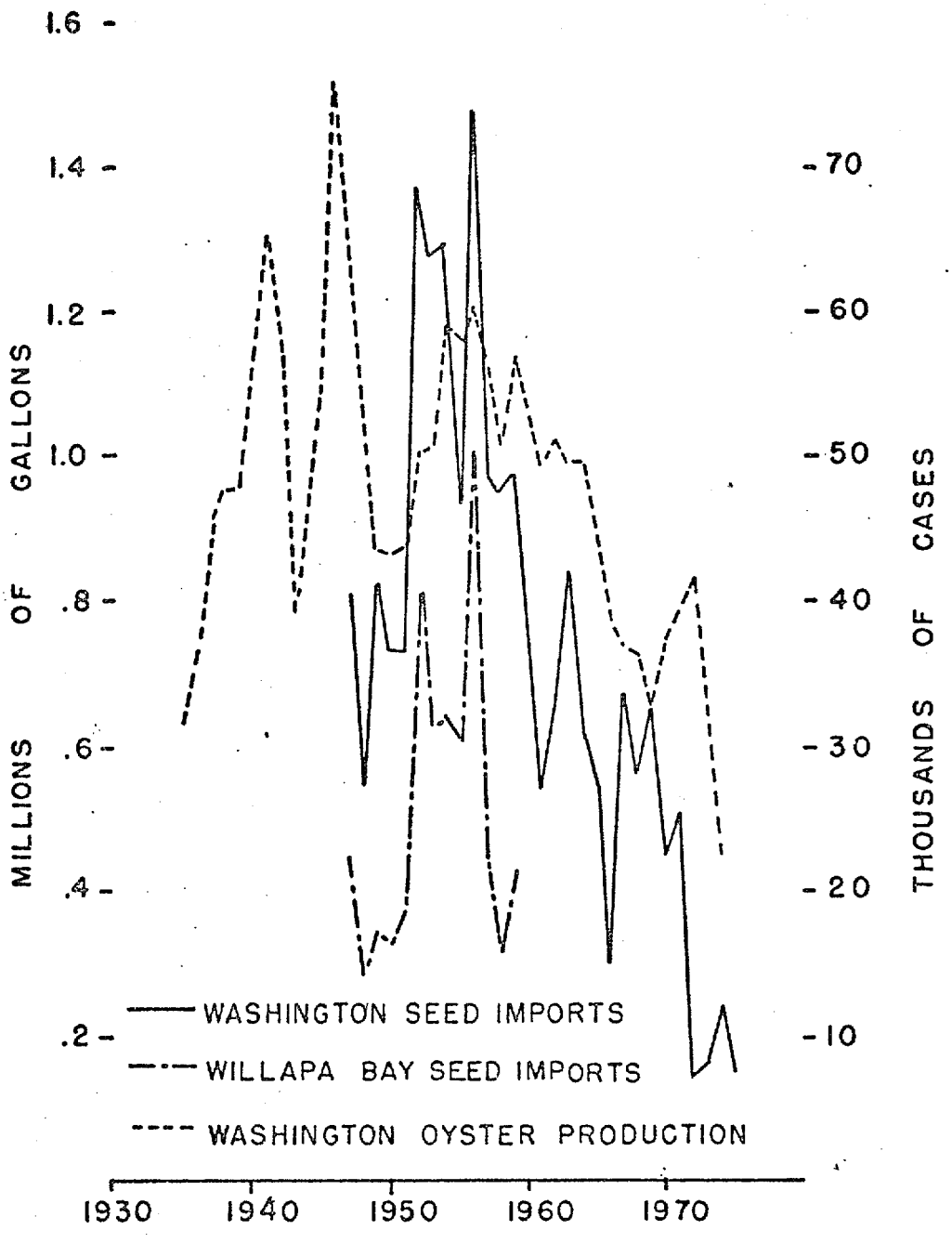
JAPANESE SEED

The introduction of the Japanese oyster (Pacific) in the late 1920's proved to be successful and the entire production of oysters from Willapa Bay presently is from this introduced species. Each year large amounts of seed are imported from Japan to continue the production. Not all seed of the Pacific oyster comes from Japan. Some areas in Washington and Canada frequently provide the conditions during the summer for the propagation of Pacific oysters. In Washington the major areas in which natural spawning and setting of Pacific oysters is often successful are Willapa Bay and Quilcene and Dabob Bays of Hoods Canal in the sound.

Seed from Japan is shipped in cases containing 15-20,000 spat usually on oyster shell. The spat are natural set from the previous year in Japan. Figure 16 illustrates the varying amounts shipped Washington for use in Washington since 1947. Figure 16 also includes case amounts for Willapa Bay for the years those numbers were available. (1947-59) It is clear that the bulk of the imported seed used in Washington is planted in Willapa Bay. As was the case earlier with the transplanting of Eastern oysters in Willapa Bay, the introduction of seed from Japan brought other organisms in addition to the oysters. These included the oyster drill, Japanese little neck clam, red crab and others. Some of these organism are predators on the oyster. Thus the legislature, in 1951, acted to give the Director of the Department of Fisheries the authority to promulgate regulations governing the importation of seed and the responsibility to require inspection of seed for disease, infestations and pests. Later the legislature (1967) required that the importer pay for the actual cost of inspection excluding the inspectors base salary.

When the trends in the volume of Japanese seed imports are compared to trends in oyster production there appears to be a general coorelation. If the Japanese seed case is assumed to produce 20 gallons of oysters and a growth period of four years is required a comparison may be made in the same terms. Figure 17 illustrates these comparisons and suggest a rather close relationship for the state production as a whole. Data on Willapa Bay seed imports are not complete enough to make similar comparisons over a long enough period to be significant.

Evnironmental changes in the bays and estuaries of Japan have reduced the capacity of many areas there to produce seed or have degraded the quality of the seed produced. With the rise in the standard of living in Japan the cost of seed



PACIFIC OYSTER SEED IMPORTS

FIGURE 16

TABLE 10

Annual seed oyster shipments to the state of Washington and the Pacific coast.

Seed year	State of Washington discharge[1]						Pacific Coast total
	Miyagi Prefecture			Kumamoto Prefecture	Other[2]	Total	
	Broken	Unbroken	Broken/ unbroken				
1947	13,240	27,242		20		40,502	56,619
1948	8,951	18,308		80	30	27,369	32,869
1949	22,968	17,031		1,000	27	41,026	46,036
1950	22,578	13,715		548	20	36,861	46,726
1951	23,806	12,710		150	2	36,668	51,901
1952	53,881	14,422		600	61	68,964	83,290
1953	52,731	10,370		682	32	63,815	70,113
1954	55,159	9,269		250	1	64,679	65,528
1955	41,378	4,924		334	44	46,680	54,216
1956	63,221	10,246		507	85[3]	74,059	100,634
1957	39,102	9,296		133	332[3]	48,863	60,063
1958	37,893	8,737		1,202	30[4]	47,862	61,119
1959	18,870	13,600	15,875	606	33[4]	48,984	61,444
1960	17,101	2,224	15,779	1,200		36,304	44,291
1961	14,643.5	4,337	7,494	1,004		27,478.5	37,128.5
1962	13,450	4,597	13,610	1,141	1	32,799	41,499
1963	15,409	6,643.5	18,598.5	1,740	1	42,392	53,416
1964	12,148	2,522	13,975	1,890		30,535	41,160
1965	4,000	2,139.5	18,905	2,238		27,282.5	37,128.5
1966	5,740	1,000	6,186	1,995		14,922	16,102
1967	5,803	3,192.5	24,780	454		34,229.5	43,557.5
1968	3,500	1,000	21,915	1,670		28,085	38,415
1969	4,000	1,125	27,375	1,100		33,600	44,707
1970	5,250	500	15,321	1,142		22,213	26,079
1971	5,300	1,405	18,423	261[5]	97[5]	25,486	30,337
1972		375	6,247	699[5]		7,321	7,321
1973			7,085	1,260[5]	1[2]	8,346	8,346
1974		1,455	10,431	520[5]		12,406	12,406
1975			7,816		100[6]	7,866	10,856

1/ Including trans-shipments to Oregon, California, and British Columbia.

2/ Experimental boxes and samples of new types of cultch.

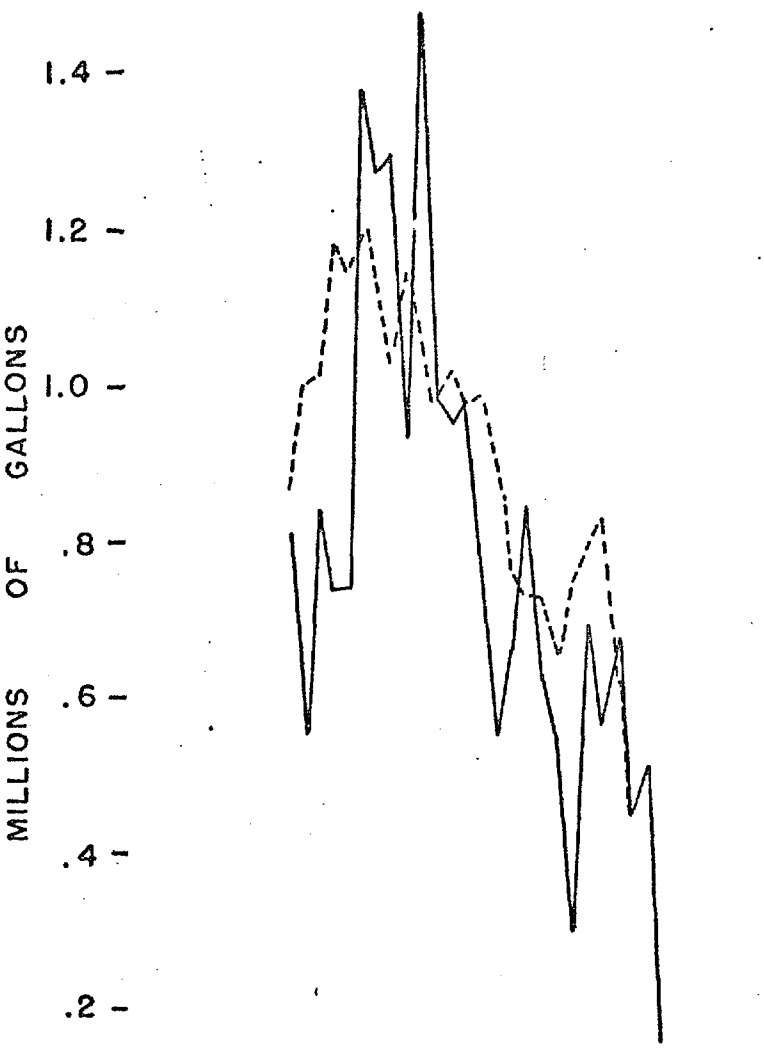
3/ Includes clam seed (197 cases), adult Kumamoto (31 cases), experimental (12 cases), and Suminoe (92 cases).

4/ Hiroshima.

5/ Kumamoto seed packed in Miyagi Prefecture.

6/ 100 plastic cases, equivalent of 50 standard cases.

From WDF Report



PREDICTED OYSTER PRODUCTION
BASED ON SEED IMPORTS
20 GAL./CASE — 4 YR. GROWTH

FIGURE 16

production has increased. In the late 1960's France suffered a major loss in its oyster industry through disease. Pacific oysters were introduced there in large amounts to fill the gap and in some areas to replace their native oyster. Large amounts of seed were transported from Japan to France by air to provide the new crop. The price of seed increased in the early 1970's and shipments to Washington were greatly reduced.

The experience of growers is that seed from Japan has the best returns and requires the least attention on the beds. However, the price is now over three times what it was twenty years ago. The ability of Japan to produce large amounts of seed beyond its own needs may continue to decline with further degredation of the enviornment there.

Japanese imports of canned and frozen oysters compete with those produced in Washington so that heavy dependence on Japan for seed results in their potential control of both costs of production and market price for the grower in Washington. In an economically depressed area, such as Pacific County, the payment of from one fourth to one half million dollars out of the area for seed reduces the economic value of the oyster industry to the county.

Many aspects of the practice of purchasing seed from Japan indicate that a substitute for Japanese seed is desireable. However, none so far developed has completely removed the dependence on this source.

NATURAL SEED

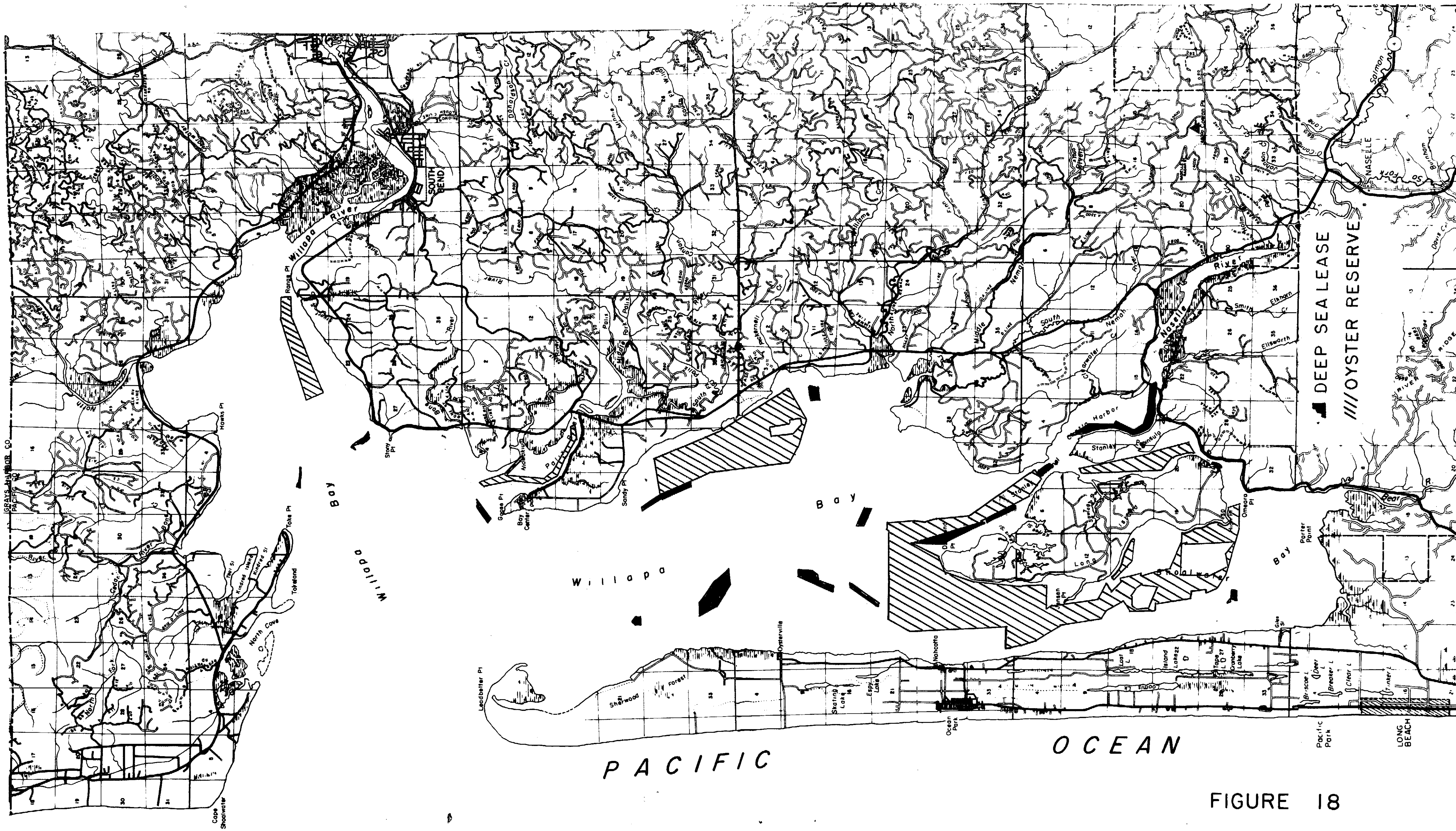
Soon after the pacific oyster was introduced into Willapa Bay it was discovered that under the proper conditions spawning took place and the resulting swimming larvae could complete their development and set to produce a "natural set". Growers use various techniques for catching this set. Oyster shell from the processing plants is broadcast in areas which, from experience, have proved to be good seed catching locations. The areas may be in channels such as that of the lower Naselle River in Chetlo Harbor where leases are acquired for this purpose. Some growers prepare shell piles on growing beds to catch seed. More commonly the oyster shell is punched and strung on wires and laid on racks low in the intertidal zone. When a set is successful the racks are emptied the following year and the shell holding the young oysters is scattered on growing beds. In the case of channel catches the shell must be dredged and transferred to growing beds. The costs in this system are primarily in labor and equipment time. If a catch is not successful in the year and shell is put out, the resulting fouling of the shell by growth of algae and attaching animals makes it useless for the seed catching the next year. The costs incurred in preparing and placing the shell then becomes a loss when there is not a satisfactory set. This loss is compounded by the need to supply seed from some other source to replace that which was expected throught natural set. Growers have worked around these disadvantages by catching several years supply of seed and holding seed in growing areas for extended periods. There are limitations to

TABLE 11

PACIFIC OYSTER SETTING
Willapa Bay

Year	Set	Year	Set
1936	Excellent	1956	Excellent
1937	Commercial	1957	Excellent
1938	Good	1958	Good
1939	Good	1959	Commercial
1940	Good	1960	Non Commercial
1941	Excellent	1961	Non Commercial
1942	Good	1962	Non Commercial
1943	Non Commercial	1963	Non Commercial
1944	Non Commercial	1964	Commercial
1945	Non Commercial	1965	Commercial
1946	Non Commercial	1966	Non Commercial
1947	Excellent	1967	Commercial
1948	Good	1968	Commercial
1949	Non Commercial	1969	Non Commercial
1950	Good	1970	Non Commercial
1951	Commercial	1971	Excellent
1952	Non Commercial	1972	Non Commercial
1953	Commercial	1973	Non Commercial
1954	Good-spotty	1974	Non Commercial
1955	Non Commercial	1975	Non Commercial

From WDF Reports 1936-1970
Excellent= 50 or more spat per shell
Good = 25-50 spat per shell
Commercial= 3-25 spat per shell



DEEP SEA LEASE
//// OYSTER RESERVE
SOUTH BEND
Willapa River
Willapa Bay
Bay
PACIFIC
OCEAN
Naselle
Nemah
Bay Center
Nahcotta
Oysterville
Ocean Park
Pacific Park
LONG BEACH
Leadbetter Pt
Tokeland
North Cove
Cape Shoalwater
Stanley Peninsula
Long Island
Shoalwater Bay
GRAYS HARBOR CO
PACIFIC CO

FIGURE 18

this practice. When the frequency of sets becomes low or the set is quite sparce for several years in a row then the natural source of seed is not satisfactory to meet the needs of growers.

Heavy natural sets have occured in the bay and seed has consequently appeared not only on the oyster shell placed in the water for that purpose but on all the living oysters in the bay, on the dikes, piling, floats, drift, etc. Such sets occured in 1936, 1941, 1947 1956, 1957, and 1971. The interval between these occurences was 5, 6, 9 and 14 years. Lesser sets have become correspondingly less frequent and have become rare since 1960. (See Table 11).

Seed catching operations have been established by local growers in other areas, primarily Quilcene and Dabob Bays, were sets are caught more frequently. This involves an additional cost in transportation and acquisition of ground and is conducted with strings of shell or shell held in plastic mesh bags. Some growers suspend their strings or bags from floats which further increases the cost of the seed obtained but produces better results. In the past the risk of no set in these other areas has not been as great as in Willapa Bay but an unsuccessful year results in a greater loss since it is less practical to retain a poor set and transport it than it is in Willapa Bay and hopes of accumulation of poor set over several years is not practical.

The Washington Department of Fisheries has established shellfish laboratories in Willapa Bay and between Dabob and Quilcene Bays to aid oysters growers in the prediction of oyster sets in those areas. Water samples are taken periodically to determine the presence of and stage of development of oyster larve. The concentration of larvae and their progress towards setting stage provides a basis for estimating when a set may occur and whether it will be of a high enough concentration to merit the introduction of shell strings into the bay. Since clean shell appears to make the best catch it is important not to immerse the shell prematurely since it soon becomes fouled and reduces its efficiency in catching seed.

Spawning is directly related to temperature and food. When the temperature begins to raise the oyster is induced to develop eggs or sperm and when these products are completely developed a critical temperature is necessary to result in spawning of eggs for fertilization which occures outside the oyster. Food must be abailable in high enough concentration to allow good development of an adequate number of eggs. Spawning by a few oysters may induce wide spread spawning in adjacent oysters. Attempts to induce spawning have involved crushing large numbers of oysters in spawning condition and dumping them in the bay in hopes of inducing spawning.

In Willapa Bay spawnings have often occurred but the larvae have not reached setting size or simply no longer appear in samples. The swimming oyster larvae actively take food and maintain themselves in the water column as they develop. They

are much more sensitive to water quality than are the adult oysters and are highly susceptable to predation by any larger filter feeding organism including their parents. They are easily carried by currents and will not survive extended exposure to the air. Food particles must be very small in order that they may injest it and the food must be suspended in the water column. The temperature of the water must remain at a relatively high level in order for them to complete their development in three weeks or less. There are many factors which alone or together may be responsible for unsuccessful development of oyster larvae. In recent years loss of the larvae before completion of their development or low levels of spawning have often provided little in the way of oyster seed for the grower.

With a good set numerous spat attach to each shell. As they grow they become crowded and tend to grow out away from the shell forming clusters. Growers break up these clusters in order to prevent smothering and to get better growth. Breaking also makes processing (opening) simpler and thus improves the yield. Breaking is usually the most expensive operation to the grower after seed is planted and before the marketable oyster is harvested. Some growers combine breaking and transplanting to reduce handling costs. Natural oyster seed is caught on shell derived from oysters grown in Willapa Bay. This shell is large and relatively thick contrasting with the thin smaller oyster shell on which the imported Japanese seed is caught. The larger and thicker local shell is more difficult to break and thus the cost of this operation is higher with natural caught seed than with imported Japanese seed.

OYSTER RESERVES

Natural oyster beds were reserved from sale or lease by the 1897 legislature. The purpose of the reserves was to conserve the supply of oysters. Licenses were required to remove oysters from these beds and management controls were outlined. The 1903 legislature established a state oyster commission whose responsibility was to manage the oyster reserves. Their duty was to survey the existing reserves, control the removal of oysters from the reserves by closures and licenses and to reseed. The oyster reserve lands were reserved from sale or lease forever in the same act.

Five oyster reserves were established in Willapa Bay including 9850 acres. They are the Willapa, Bay Center, Nemah, Long Island and Long Island Slough reserves. Figure 18 illustrates their locations. The native oyster industry in Willapa Bay had declined by the 1920's and much of the deeded land had been foreclosed for taxes. The 1929 legislature authorized the commissioners of public lands to sell or lease tidelands in the reserves in the same manner as second class tidelands with the concurrence of the Director of Fisheries and Game.

These early legislative acts were directed toward reserves for the native oyster. With the introduction of the Japanese (Pacific) oyster the natural bed status of the reserves was altered but the use was similar. By 1947 the legislature declared a policy of

improvement toward productivity of the reserves and stated the basic purpose of the reserves was to provide a seed supply for owners of oysterlands. Later (1969) the policy was modified by the legislature to allow those other than owners of oysterlands to purchase seed from the reserves and authorized the director to allow harvest of oysters from the reserves for personal use. Seed from the oyster reserves consists of oysters of various ages which have been caught from natural set on loose shell dumped on the ground for that purpose.

HATCHERY SEED

In the 1940's it became clear that oyster larvae were extremely sensitive to certain metalic ions which were found in most metal tanks, plumbing materials and pumps available at that time. When these were removed from laboratory systems, which is now easily done by substituting plastics for metal parts, it became possible to routinely rear oyster larvae through development to their metamorphisis as oysters. This allowed investigators to identify foods, usually single celled algae, which were acceptable to the larvae and provided good growth. At about the same time algologists were involved in developing systems which would allow the growth of large volumes of single celled algae to examine its possible use as a human food supplement. They were in turn using a theoretical base of knowledge developed by bacteriologists. The combination of these various technologies supplied the potential for the large scale rearing of oyster larvae under controlled conditions to produce seed.

Commercially oriented oyster seed hatcheries appeared in Japan, England and on the East Coast of the United State in the 1950's. Privately owned commercial oyster seed hatcheries now exist in many oyster growing areas, including Willapa Bay and Puget Sound in Washington.

Presumably the hatchery has the advantage of production at any time of year, selection of parentage for the improvement of oyster characteristics, the ability to vary the type of setting material (cultch) to find the most practical for both seed producer and grower, control of density of the set and reduction of transportation costs.

In contrast the hatchery requires a large capital outlay, some technical staff, considerable attention and is highly susceptible to water quality changes. At present hatcheries have not been able to produce a significant portion of the seed required. This has been due to operational problems apparently from pollution and to an incomplete understanding of the requirements of oyster larvae.

SUMMARY

Each of the available sources of seed has advantages and disadvantages. None of the sources can be relied upon as a sole source either because of price or availability in any given year. As a result most growers now obtain their seed from a combination

of sources in order to insure a supply. However, when the price of seed from one source is so high the grower cannot anticipate a profit in using it and at the same time other cheaper sources cannot supply his needs, the grower is in an untenable situation. Since 1960 this condition has frequently been the case for many growers.

The price and availability of seed is as important a factor in production as is growing and fattening oysterland.

MARKETS

PRODUCTS

Pacific oysters were marketed as fresh opened or canned for the first twenty years of their production on the West Coast. In the early 1950's canned oyster stew was introduced. Figure 19 illustrates west coast production of canned oysters and canned oyster stew from 1931 through 1959. The available production statistics for Washington and Willapa Bay combine canned oyster production and canned oyster stew production and are illustrated in Figure 20. Since oyster stew contains less than 15% oysters it is not possible to directly compare these production figures to total gallonage produced in Willapa Bay. The trend has been a downward one for the period the records are available.

The larger producers in Willapa Bay are vertically integrated operations. They handle the oyster from set catch to market. They are all canners but market some fresh oysters. They also buy shellstock and opened oysters from smaller producers. Two of the companies are absentee owned and one of these is foreign owned. Since the larger producers control over one half the productive potential of the bay their production and marketing strategies significantly effect the oyster production statistics for the bay as a whole.

An estimated 80% of the oysters harvested in Willapa Bay are opened locally.

IMPORTS

Imports have long been a major element in the marketing of processed oysters. Imports to Washington are from Japan, Korea, Hong Kong and Canada. Imports from other areas of the United State compete with markets of Washington producers in these areas. Figure 21 compares imports with the production of oysters in Washington. (See Table 16).

As the figures show imports to Washington exceed the local production in 1974. This is a result of a change in the character of the importers. After 1971 the large oyster producers imported canned and frozen oysters, primarily from Korea. These imports were marketed and processed in lieu of producing their own crops. As a result the local production dropped drastically and a new peak appeared in the volume of imports.

Over the last several years more oysters have been imported to Willapa Bay than have been harvested here. This has greatly reduced the economic value of the oyster industry to Pacific County.

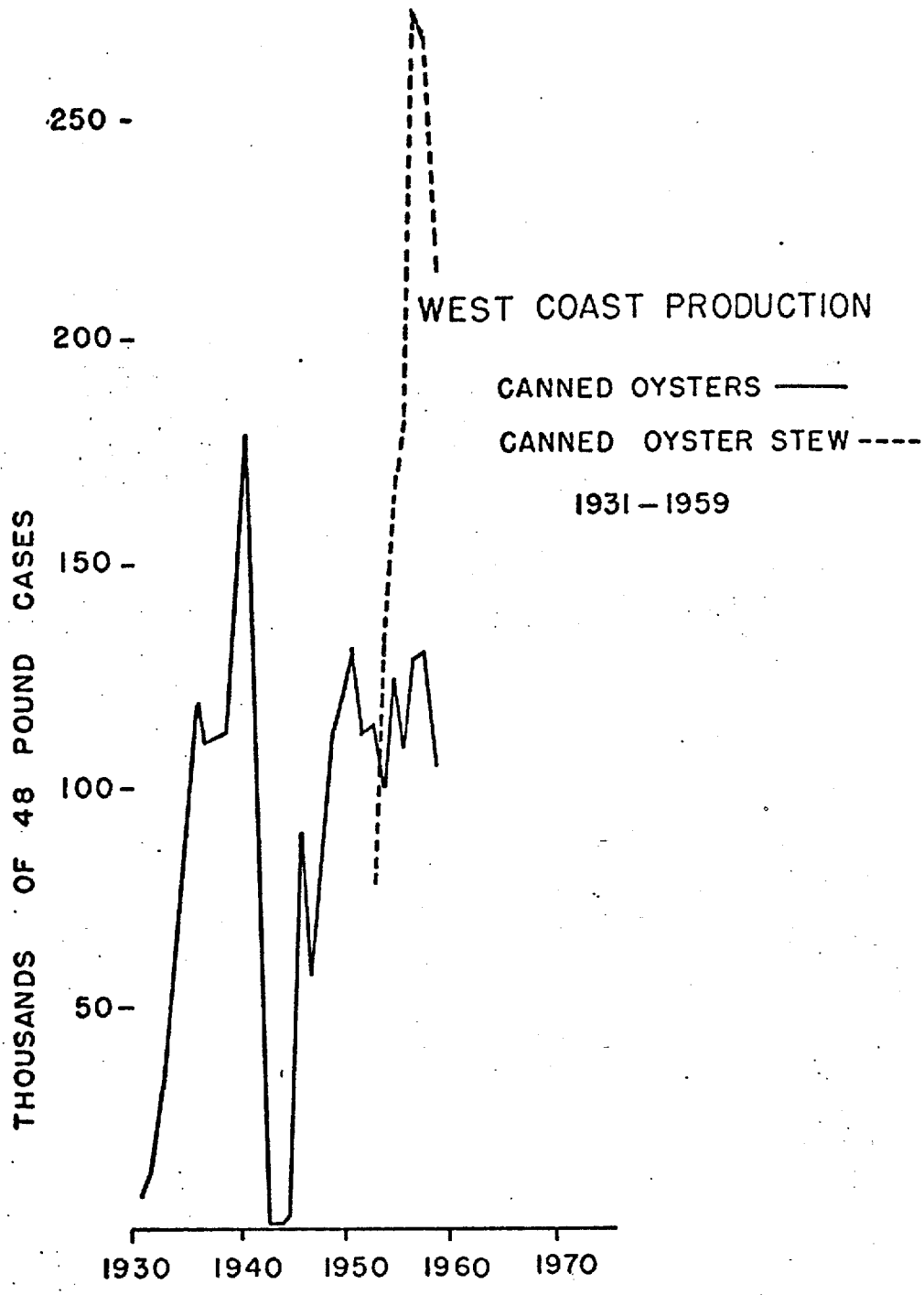

250 -
200 -
150 -
100 -
50 -
THOUSANDS OF 48 POUND CASES
WEST COAST PRODUCTION
CANNED OYSTERS ——
CANNED OYSTER STEW ----
1931 – 1959
1930
1940
1950
1960
1970

FIGURE 19

TABLE 12

PACIFIC CANNED OYSTERS

Year	Cases	Year	Cases
1931	7,930	1945	3,184
1932	12,223	1946	89,050
1933	32,315	1947	57,205
1934	68,323	1948	83,489
1935	88,062	1949	113,989
1936	118,853	1950	120,742
1937	110,872	1951	132,140
1938	111,348	1952	112,415
1939	112,549	1953	114,687
1940	148,870	1954	100,687
1941	178,445	1955	124,497
1942	72,315	1956	109,559
1943	583	1957	128,493
1944	none	1958	131,266
		1959	106,881

TABLE 13

PACIFIC CANNED OYSTER STEW

Year	Cases	Year	Cases
1952-53	78,536	1955-56	182,179
1953-54	134,111	1956-57	273,288
1954-55	170,058	1957-58	268,907
		1958-59	216,683

Cases of 48 cans
Data from Pacific Fisherman 1960

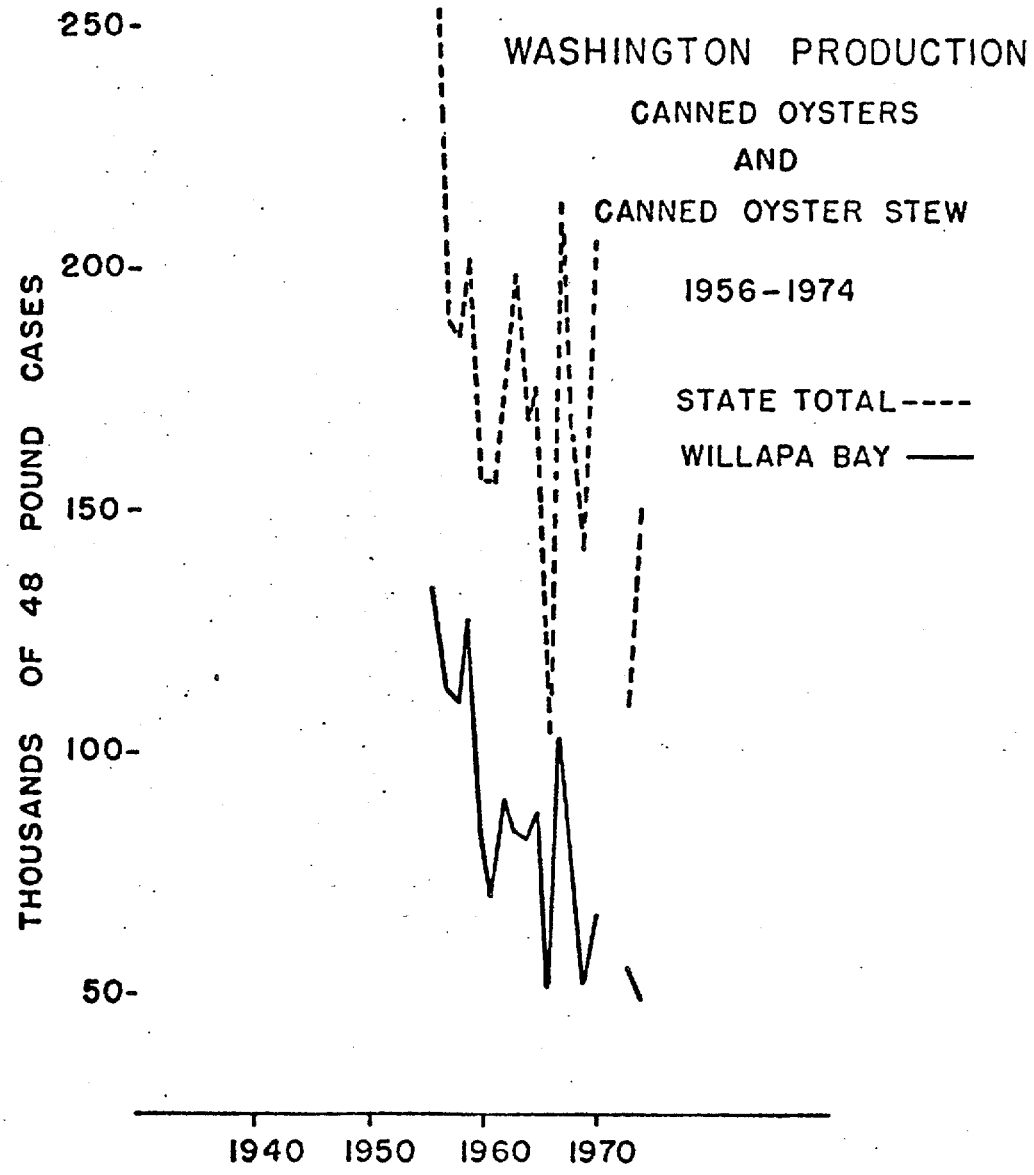

WASHINGTON PRODUCTION
CANNED OYSTERS
AND
CANNED OYSTER STEW
1956-1974
STATE TOTAL----
WILLAPA BAY ——
THOUSANDS OF 48 POUND CASES
250-
200-
150-
100-
50-
1940
1950
1960
1970

FIGURE 20

TABLE 14

PACIFIC CANNED OYSTERS AND OYSTER STEW

Year	Willapa Bay	Total Washington
1956	133,776	253,501
1957	113,926	190,144
1958	110,309	186,050
1959	126,960	202,774
1960	84,126	155,398
1961	70,082	155,161
1962	89,524	177,697
1963	83,445	198,096
1964	82,405	167,782
1965	87,201	176,784
1966	51,864	103,065
1967	102,723	219,491
1968	80,828	165,849
1969	52,147	141,658
1970	66,747	206,270
1971		
1972		
1973	56,156	109,073
1974	48,899	150,850

48 pound cases
Data from WDF

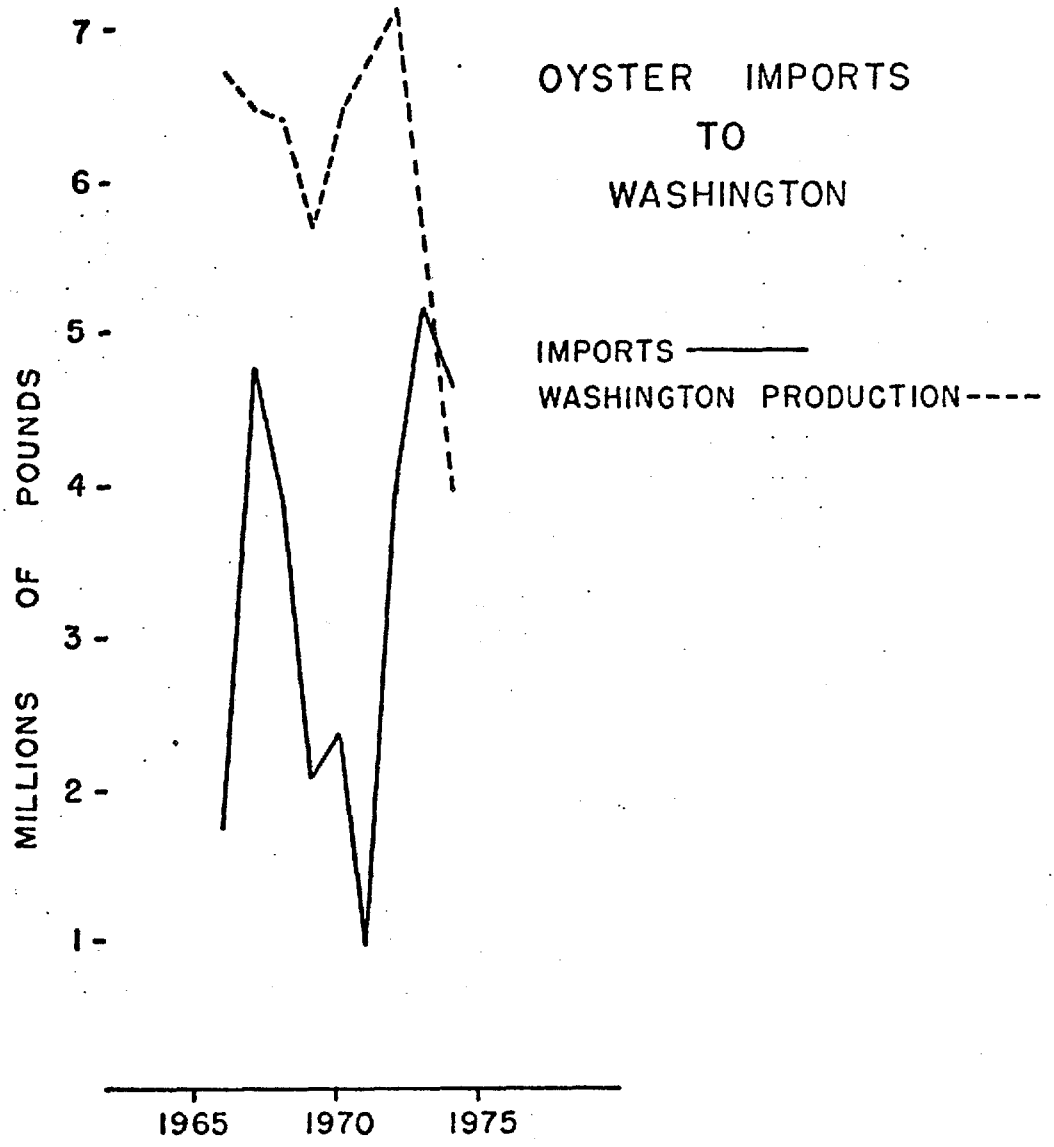

OYSTER IMPORTS
TO
WASHINGTON
IMPORTS
WASHINGTON PRODUCTION
MILLIONS OF POUNDS
7
6
5
4
3
2
1
1965
1970
1975

FIGURE 21

TABLE 15

Oyster Imports to Washington , in pounds compared with Washington Production

(Imports from Canada,West Germany,Korea Hong Kong, and Japan)

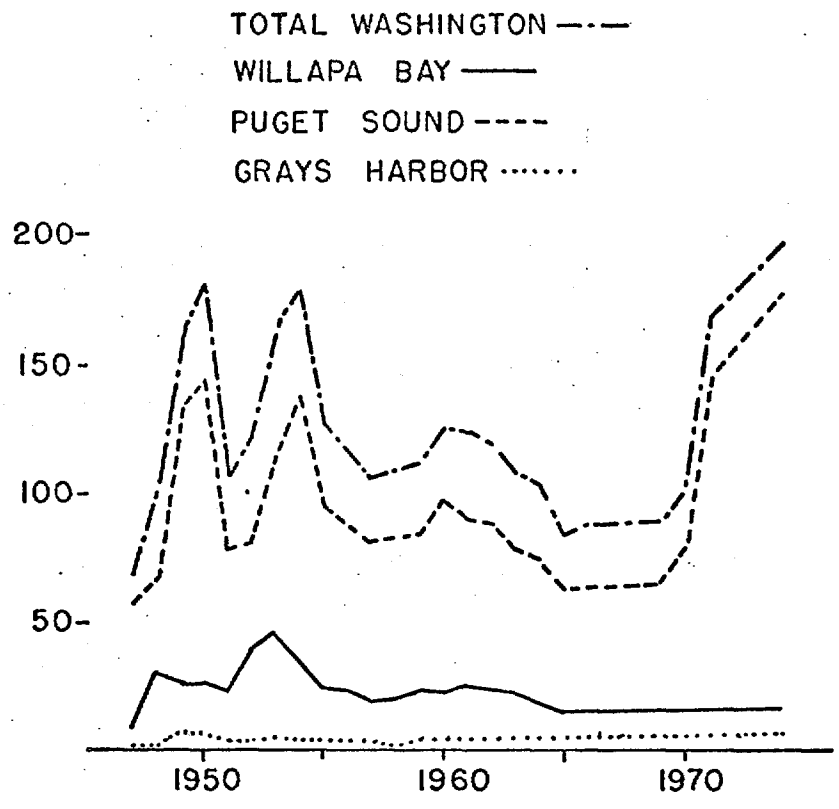
Year	Canned	Value	Freshor Frozen	Value	Total Value	Total Pounds	Washington
1966	956,713	$236,873	824,607	$329,554	$566,427	1,781,320	6,722,750
1967	1,696,907	$461,961	3,099,420	$775,673	$1,237,634	4,796,327	6,490,403
1968	1,561,174	$438,335	2,343,151	$550,201	$988,536	3,904,325	6,414,810
1969	1,290,048	$380,573	772,883	$359,168	$739,741	2,063,131	5,708,373
1970	799,860	$259,521	1,542,650	$704,109	$963,540	2,342,510	6,506,099
1971	200,826	$100,879	786,062	$464,722	$565,601	986,888	6,793,751
1972	2,597,097	$1,424,871	1,343,676	$1,093,963	$2,518,834	3,940,773	7,272,127
1973	3,456,606	$1,683,543	1,661,761	$1,345,246	$3,028,789	5,118,367	5,622,036
1974	2,453,066	$1,253,208	2,162,215	$1,685,381	$2,938,589	4,615,281	3,982,096

Import data from National Marine Fisheries Service
Washington Production Data from Washington Department of Fisheries

PRODUCTION FACTORS

Production figures show the same long term trends as does available area of productive oysterland, volume of imported oyster seed and individual product types (See Figures 8, 16 and 20). It was also shown earlier that when producers become importers production figures are effected. This practice as well as the practice of holding crops from market for a better price can only be a short term effort since if the oysters are still being farmed they will eventually have to be harvested. If oysters are not farmed then the importer becomes a broker and is no longer an element in the production of oysters except as a foreign comeptitor, and the grower who witholds and does not farm essentially is no longer in business. In either event the effect is short term and cannot account for long term trends. (See Figure 11, 1971-74).

Long Term trends in production are a reflection of changes in potential productivity. Reduction in available productive land, increase in growing time required and lower frequency of natural sets are all attributable to environmental changes and reflected as increases in cost. If costs increase disproportionately to market values then production goes down. So that market trends in volume basically reflect potential productivity changes if a demand for the product remains.



OYSTER FARM LICENSES

FIGURE 22

TABLE 16

OYSTER FARM LICENSES

Year	Grays Harbor	Puget Sound	Willapa Bay	State Total
1947	1	59	10	70
1948	3	69	31	103
1949	8	133	26	167
1950	8	146	27	181
1951	5	79	24	108
1952	4	82	39	125
1953	7	116	45	168
1954	6	139	35	180
1955	6	96	25	127
1956	5	89	24	118
1957	5	81	19	105
1958	2	84	21	107
1959	5	84	23	112
1960	6	98	22	126
1961	6	92	27	125
1962	6	89	25	120
1963	7	78	23	108
1964	6	75	18	99
1965	5	63	16	84
1966	6	65	17	88
1967	5	65	17	87
1968	6	64	18	88
1969	5	67	17	89
1970	5	80	16	101
1971	5	146	18	169
1972	6	157	16	179
1973	6	168	15	189
1974	6	177	15	198

Data from WDF Annual Reports